instruction manual

INSTRUCTION MANUAL

MODELS 7151R & 7161

PRESET EPUT® METER

Beckman®

Berkeley Division

INSTRUCTION MANUAL

MODELS 7151R & 7161
PRESET EPUT® METER

Serial 457

NOTE

If model number is followed by one or more letters, the instrument covered by this manual has been modified. See section on modifications.

Berkeley Division
BECKMAN Instruments, Inc.

Richmond 3, Calif.
December 1958

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in posession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

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MODIFICATIONS (7000 Series)

DRAWINGS

Diagrams covering Model 7151 Only:

Master Schematic Diagram, Dwg. No. 7151 D 1
Multivibrator Frequency Dividers, Dwg. No. 7151 C 3

Diagrams covering Model 7161 Only:

Over-All Schematic, Dwg. No. 7161 D 1
Count Gate, Control Circuitry and DCU Sockets, Dwg. No. 7361 D 2
Multivibrator Frequency Dividers, Dwg. No. 7161 C 6

Diagrams covering Both Models 7151 & 7161:

Input Trigger Channel, Dwg. No. 7000 C 300
Oscillator & Shaper, Dwg. No. 7000 C 419
Preset Digital Divider, Dwg. No. 7151 D 2
Power Supply, Dwg. No. 7370 C 100

APPENDICES

Instruction Manual, Model 775 DCU
Instruction Manual, Model 785A DCU
Instruction Manual, Model 775P DCU
Instruction Manual, Model 775P/1 DCU

1. INTRODUCTION

1.1 GENERAL DESCRIPTION

The Preset EPUT®, Meter is a multi-purpose electronic counter which will perform a number of different operations. The instrument consists of the following functional parts housed in a single cabinet (see Fig. 1):

(a) An input trigger channel. This circuit generates one pulse for every cycle of the input signal.

(b) A crystal-controlled clock-pulse generator. This unit generates pulses separated by a precise time interval. Model 7151 offers three selectable intervals: 1.0 ms, 0.1 ms and .01 ms. Model 7161 offers, in addition, a one-microsecond interval.

(c) A four-decade digital divider. This will divide pulse frequencies by any number from one to 9,999, depending upon the setting of four ten-position selector switches.

(d) An electronic gate with pulse-actuated controlling circuitry. A pulse applied to the control circuitry will open the gate; a later pulse will close it. In the interval, the gate will be open to pass other pulses to counting circuitry.

(e) A chain of cascaded decimal counting units. These units count and indicate the number of pulses emerging from the gate. Model 7151 contains five indicating DCU's; Model 7161 contains six.

(f) A power supply to generate plate and filament voltages for the above circuits.

The particular function the instrument will perform depends upon how the functional parts are interconnected. All interconnections are made simply by positioning the front-panel FUNCTION switch. Each mode of operation takes its name from the FUNCTION switch engraving at that position. For a description of each mode, see sections 2.4 through 2.9.

1.2 TECHNICAL CHARACTERISTICS

Note: See sections 2.4 through 2.9 for characteristics of each mode of operation.

1.2.1 Over-All Characteristics.

Count Indication: Appears in the form of illuminated decimal digits.
Duration of display is continuously variable from 0.1 to 10 seconds.
Model 7151 displays five digits, will register a maximum of 99,999 counts.
Model 7161 displays six digits, will register 999,999 counts.

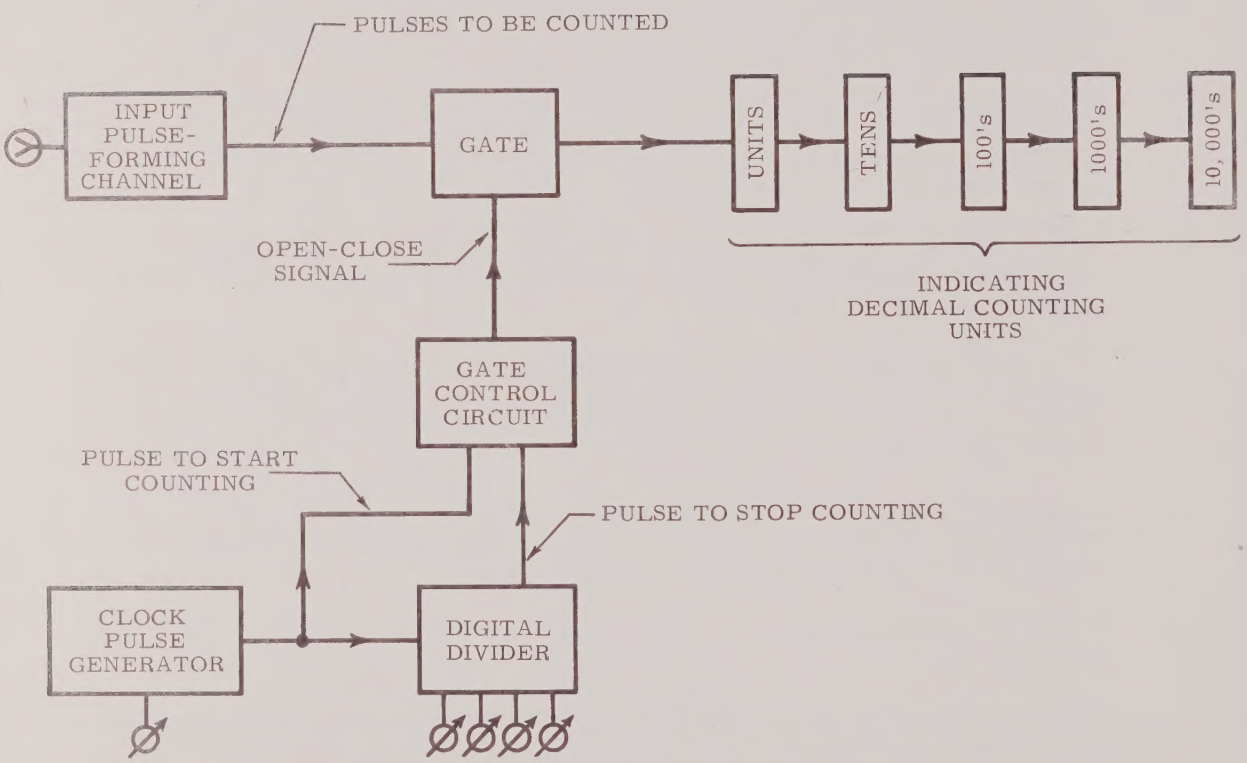

FIG. 1. Simplified block diagram of Model 7151 when set up to count events for a precise time interval. The block diagram for the Model 7161 would be identical except for one more decimal counting unit (registering "100, 000's") in the indicator chain.

Readout Facilities: A modified binary code representing each decimal digit registered is available at a rear-panel connector.

Power Requirements: 117 v ±10%, 50 to 60 cps. Model 7151 draws about 260 watts; Model 7161, about 300 watts.

Over-All Dimensions: With cabinet: 21 in. wide, 11 in. high, 17-1/4 in. deep. Without cabinet: 19 in. wide, 8-3/4 in. high, 17-1/4 in. deep. (Designed to fit in standard 19 in. relay rack.)

Weight with Cabinet: Model 7151: Approximately 48 lbs.
Model 7161: Approximately 50 lbs.

1.2.2 Clock-Pulse Generator.

Output Pulse Interval: Model 7151: 1 ms, 0.1 ms & .01 ms.
Model 7161: 1 ms, 0.1 ms, .01 ms & 1 μsec.

Frequency Error of Crystal Oscillator: Model 7151: Set to within 1 part in 10^6 at the factory; drifts less than 1 part in 10^6 per day.

Model 7161: Set to within 1 part in 10^7 at the factory; drifts less than 3 parts in 10^7 per week.

1.2.3 Digital Divider.

Input: Pulses from an input trigger channel or the clock-pulse generator. Maximum input frequency is 10 kc.

Output: Every Nth input pulse, where N is any number from 1 to 9,999.

Purpose: Divide input pulse frequency by N. Multiplies input pulse interval by N.

1.2.4 Input Trigger Channel.

Type of Input Signal: Channel generates a pulse for each input voltage excursion through a selected trigger voltage level. If this input is an AC signal, one effective pulse will be generated for every cycle.

Input Sensitivity: Input excursions must be at least 0.3 volts in amplitude. This means that an AC signal 0.3 volts peak-to-peak (100 millivolts rms) will trigger the input channel successfully. An input attenuation control is provided to attenuate the input voltage by a factor of 10 or 100 thus decreasing the sensitivity to 3 or 30 volts peak-to-peak respectively.

Input Coupling: Choice of AC or DC.

Input Frequency Range: DC to 100 kc for the Model 7151, and DC to 1 mc for the Model 7161. Sensitivity begins to decrease appreciably when frequencies below 5 cps are AC coupled. Maximum input frequency is 10 kc during operations in which the channel output drives the digital divider.

Input Impedance: 10 megohm in parallel with approximately 35 $\mu\mu$f. Impedance begins to drop below 10 megohms when input voltage (after attenuation) rises above +1 v DC, falling to approximately one megohm at +10 v DC.

Trigger Voltage Level: Instantaneous voltage at which the attenuated signal triggers the input channel may be varied continuously from -1 v to +1 v.

Trigger Slope: Input channel will trigger on either a positive-going or a negative-going input voltage excursion.

1.3 APPLICATIONS

Frequency Measurements.* By counting the individual cycles of an input signal, accuracies as great as a few parts in 10^7 (Model 7161) or a few parts in 10^6 (Model 7151) are possible. See section 2.4, "E/UT X N Operation".

Flow Measurements.* Flow measurements require a transducer which generates one pulse or signal cycle each time a certain volume of liquid passes a given point. By selecting the proper counting period a rate of flow indication can be obtained in any desired units. See section 2.4, "E/UT X N Operation". Total flow can also be indicated in any desired units using "INPUT/N" operation (See section 2.6). Modification K will adapt instrument to input signals 5 mv in amplitude at 5 cps.

Tachometry.* Rotational rates can be indicated directly in any units desired. This requires an input transducer which generates a signal whose frequency is proportional to the rate of rotation. See section 2.4, "E/UT X N Operation".

Measurement of Pressure, Temperature and Strain.* Transducers are available which generate an electrical signal with a frequency that changes in proportion to change in pressure, temperature or strain. When cycles of this signal are counted during a properly selected period of time, an indication can be obtained in any desired units. See section 2.4 "E/UT X N Operation".

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*For detailed description of method used write for Data File 111, "How to Make Frequency Measurements".

Timing of Events.** The instrument will time the interval separating two events represented by voltage excursions at the input jack. See section 2.7, "PERIOD X N Operation".

Viscosity Measurements.** The instrument can be used to measure the velocity with which an object falls through a liquid. This is done by measuring the time required to pass between two points, using transducers such as photocells which generate a signal as the points are reached. See section 2.7, "PERIOD X N Operation".

Use as a Preset Counter. The digital divider in the instrument can be used as a preset counter-controller which will produce an output signal after a preselected number of input cycles. See section 2.6, "INPUT/N Operation".

Time Interval Generation. The instrument will generate sharp voltage pulses at an output jack. The pulse interval is precise and selectable over a wide range. See section 2.8, "TIG Operation".

Producing Time Delays. Used as a variable time delay generator, the instrument will produce an output pulse at a precise preselected interval after an input pulse is applied. See section 2.9, "DELAY Operation".

Telemetry. Binary coded signal representing registered count is available at a rear-panel connector. See section 2.1.14.

1.4 BECKMAN ACCESSORIES

Digital Recorder. The Model 1452 Digital Recorder is available to print the registered count at the end of each counting period. The recorder prints decimal digits on a standard adding machine tape.

In-Line Indicator. Models 5915 and 5916 are designed for use with Models 7151 and 7161 respectively. The indicator displays the registered count at the end of each counting period. The display appears in large, bright red digits on a single horizontal line. Because the digits are about 1-1/4 inches high and lie in the same vertical plane, the indicator may be read from across a room and at nearly any angle to its face.

Transducers. The Berkeley Division manufactures a variety of transducers which will generate input electrical signals for the counter in response to mechanical or optical events.

**For detailed description of methods used write for Data File 112, "How to Make Time Interval Measurements".

Thumbswitches select factor, N, by which digital divider will operate.
Illuminated digits display count
Varies length of time count will be displayed
Pushbutton resets DCU indicators to zero
Input signal is fed to this connector
Selects clock pulse interval
Determines whether positive or negative slope of input signal will trigger counts
Determines at what voltage level on input signal counts will be triggered
Selects mode of operation
1. Selects AC or DC input coupling
2. Attenuates input signal by factor indicated

FIG. 2. The Model 7151 with its operating controls and indicators.

2. OPERATION

2.1 CONTROLS, CONNECTORS AND INDICATORS

The purpose of this section is to supplement the step-by-step operating instructions which appear in sections 2.3 through 2.10. The following list includes auxiliary connectors but not controls used to adjust certain circuits when servicing the instrument. Those controls are listed in section 3.1.

2.1.1 FUNCTION Switch. Located on front panel. The position of this switch determines what operation the instrument will perform. See sections 2.4 through 2.9 for descriptions of each operation.

2.1.2 TIME MILLISECONDS Switch. Located on front panel. Pulses from the clock-pulse generator will occur at the interval indicated by this switch. Positions below 0.1 ms are shown in red to indicate that the clock-pulse generator cannot be used to drive the digital divider at these positions.

2.1.3 Input Jack. Located on front panel. Each cycle of the signal fed to this connector causes the input trigger channel to generate a pulse.

2.1.4 ATTENuation Control. Located on front panel. Has two functions: (1) Couples signal at input jack to input trigger channel either directly (on DC side) or through a capacitor (on AC side), (2) Attenuates voltage at input jack by factor to which set. See section 2.10.

2.1.5 TRIGGER Control. Located on front panel. The position of this control determines at what instantaneous voltage the attenuated input signal will trigger the input channel. This level may be varied continuously from approximately -1 v. to +1 v. See section 2.10.

2.1.6 SLOPE Switch. Located on front panel. The position of this control determines whether positive-going (+) or negative-going (-) input voltage excursions will trigger the pulses which affect succeeding circuitry.

2.1.7 Count Indicators. Illuminated decimal digits on the front panel indicate how many counts have been registered.

2.1.8 Digital Divider Switches. These are four ten-position thumbswitches located on the front panel and labeled "N". The switches may be set to any number from "0001" to "9,999" and the divider will divide its input pulse frequency by that number. Division occurs in such a way (by gating every N input pulse) that the result is to multiply the input pulse interval accurately.

2.1.9 DISPLAY Time Control. Located on front panel. The position of this control determines how long the count indication will be displayed before the instrument resets to a registered count of zero. If this control is rotated clockwise until a switch click is heard, the instrument will retain the indication until the RESET button is pressed. After resetting to zero, the instrument will begin counting again as soon as a "start counting" signal occurs

2.1.10 RESET Button. Located on front panel. Resets instrument to a registered count of zero when pressed.

2.1.11 TIME Jack. Located on rear panel. See section 2.8, "TIG Operation".

2.1.12 SCOPE Jack. Located on rear panel. The voltage at this jack is about -45 v. with respect to ground when the gate is closed, and at approximately ground level when the gate is open. An oscilloscope connected to this jack will display a square wave whose width corresponds to the length of time the gate is open, or in other words, to the counting period.

2.1.13 FREQuency Jack. Located on rear panel. A sine wave signal at the oscillator frequency is available at this jack.

2.1.14 DIGITAL RECORDER Jack. Located on rear panel. Each DCU generates a four-line code representing the digit it is displaying. These lines terminate at the DIGITAL RECORDER socket at the rear of the instrument. The Model 1452 Digital Recorder plugs directly into this socket. The socket also makes mutual control connections between the counter and the recording device.

The four-line code is shown in Table I. In the tabulation, a "0" represents a negative potential of 15 volts or more with respect to ground; a "1" represents a potential at ground level or somewhat positive with respect to ground.

Table I. Four-Line Binary Code

DECIMAL DIGIT REGISTERED	FIRST BINARY STAGE	SECOND BINARY STAGE	THIRD BINARY STAGE	FOURTH BINARY STAGE
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	1	1	0
5	1	1	1	0
6	0	0	1	1
7	1	0	1	1
8	0	1	1	1
9	1	1	1	1
No Digit	0	0	1	0

Table II gives the pin numbers on the DIGITAL RECORDER socket for the four binary lines of each decimal digit position.

Table II. Identification of Pin Numbers on Digital Recorder Socket

ORDER OF DIGIT READ	FIRST BINARY STAGE	SECOND BINARY STAGE	THIRD BINARY STAGE	FOURTH BINARY STAGE
Highest	Pin 4	Pin 3	Pin 2	Pin 1
Second	8	7	6	5
Third	12	11	10	9
Fourth	16	15	14	13
Fifth	20	19	18	17
Sixth *	24	23	22	21

NOTE: Pin 39 carries a control signal from the counter. This pin is negative during the display period and positive from reset until the end of the next counting period.

Pin 40 is the "inhibit reset" line. When this pin is grounded the counter cannot reset.

Pins 26, 30 (7151 only), 31, 32 and 38 are grounded. Pins 25, 27 and 28 are connected to the -35 volt supply. Pin 29, pin 30 (7161 only) and pins 33 through 37 remain unconnected.

*On instruments having only five indicating DCU's, these pins are permanently wired to produce the "no digit" code, 0010.

2.2 INSTALLING AND APPLYING POWER

The instrument may be located in nearly any convenient location. Simply plug the power cord into a 117 v. (±10%), 50 to 60 cps source.

On the Model 7161, the oscillator crystal oven becomes energized as soon as the power cord is connected even though the POWER switch is off. Starting cold, the oven will bring the crystal to the correct, stable temperature within one hour. Only then will the instrument perform with maximum accuracy. Therefore, if the instrument is to be used intermittently, leave the power cord connected at all times to avoid waiting while the crystal oven warms. The power consumed by the crystal oven is negligible and no other circuitry is energized. To energize the remaining circuitry, turn the POWER switch on. After a two-minute warmup, the instrument will be ready for use.

On the Model 7151, the crystal oven is not energized until the POWER switch is turned on. For stable operation of the oscillator, the proper warmup period should therefore be allowed.

2.3 TESTING FOR PROPER OPERATION

With the FUNCTION switch at TEST, the instrument counts cycles of the crystal oscillator frequency for a period equal to the TIME MILLISECONDS switch setting multiplied by the number to which the digital divider switches are set. To test the multivibrator frequency dividers and the high-speed decimal counting units, proceed as follows:

(1) Place the FUNCTION switch at TEST. The SLOPE switch may be at either position.

(2) Set the digital divider switches (labeled N) to indicate "0001".

(3) Adjust the DISPLAY time control so that the illuminated count indication on the front panel will persist long enough to be read conveniently. Note that if the DISPLAY control is turned clockwise until a switch click is heard, the count indication will persist until the RESET button is pressed. At all other positions the indication will remain displayed for 0.1 to 10 seconds, depending on the setting. The instrument will then reset to zero automatically and begin another counting period.

(4) Place the TIME MILLISECONDS switch successively at every setting except the smallest and note the count indication at each position. The count indications should be as listed in Table III. If incorrect indications appear, adjust the multivibrator frequency dividers as described in section 3.1.5.

To test the digital divider and the remaining decimal counting units, turn the TIME MILLISECONDS switch to 0.1. Then, set each of the four thumbswitch selectors to each of its ten possible positions, and observe the count indication at each position. The indications should be as given in Table IV.

Table III. Counter Test Indications

TIME SWITCH POSITION	CORRECT COUNT INDICATION MODEL 7151	MODEL 7161
.001	---	1
.01	Any	10
0.1	10	100
1.0	100	1000

2.4 "E/UT X N" (Events-Per-Unit-Time) OPERATION

What Kind of Measurement is Made. With the FUNCTION switch at E/UT X N, the instrument will count cycles of the input signal for a period equal to the TIME MILLISECONDS setting multiplied by N, the digital divider setting. For example, with the TIME MILLISECONDS switch at 1.0, and the digital divider switches at "4168", the unit will count for 4.168 seconds.

Operating Characteristics.

Maximum Counting Rate: Model 7151: 100,000 events per second.
Model 7161: 1,000,000 events per second.

Length of Counting Period: May be varied from 0.1 milliseconds to 1000 milliseconds in steps of one tenth of a millisecond. May be varied from 1000 milliseconds to 9,999 milliseconds in one-millisecond steps. The counting time may be manually extended to any multiple of the automatic time interval selected (see Section 2.5, "SCAN Operation").

Accuracy: ±One event ±accuracy of crystal oscillator frequency.

Maximum Number of Events Registered: Model 7151: 99,999
Model 7161: 999,999

Operating Procedure:

(1) Place the FUNCTION switch at E/UT X N. The SLOPE switch may be at either position.

(2) Place the TIME MILLISECONDS switch at 0.1 or 1.0 milliseconds. (IMPORTANT: The instrument will not perform this operation with the TIME MILLISECONDS switch at .01 or .001 ms.)

(3) Set the digital divider switches to a number which, when multiplied by the TIME MILLISECONDS setting, will equal the desired counting period.

Table IV. Digital Divider Test Indications

DIVIDER SWITCH SETTING (N) 1,000's	100's	10's	1's	CORRECT COUNT INDICATION MODEL 7151	MODEL 7161
0	0	0	1	10	100
0	0	0	2	20	200
0	0	0	3	30	300
0	0	0	4	40	400
0	0	0	5	50	500
0	0	0	6	60	600
0	0	0	7	70	700
0	0	0	8	80	800
0	0	0	9	90	900
0	0	1	0	100	1,000
0	0	2	0	200	2,000
0	0	3	0	300	3,000
0	0	4	0	400	4,000
0	0	5	0	500	5,000
0	0	6	0	600	6,000
0	0	7	0	700	7,000
0	0	8	0	800	8,000
0	0	9	0	900	9,000
0	1	0	0	1,000	10,000
	thru				
0	9	0	0	9,000	90,000
1	0	0	0	10,000	100,000
	thru				
9	0	0	0	90,000	900,000

(4) Couple a signal to the input jack and adjust the ATTENuation and TRIGGER controls as described in section 2.10, "Input Adjustments".

(5) Adjust the DISPLAY time control for a convenient reading.

2.5 "SCAN" OPERATION

In this mode of operation, the operator can extend the total counting period to any multiple of the automatic counting period selected under E/UT X N operation. For example, if the instrument is to count for 60 seconds, a five-second automatic counting period could be selected under E/UT X N operation, and the instrument allowed to count for 12 five-second periods. Considering the total counting time desired as N automatic counting periods, proceed as follows:

(1) Follow steps 1 through 4 of section 2.4, "E/UT X N Operation".

(2) Rotate the DISPLAY time control clockwise until a switch click is heard.

(3) Press the RESET button. The instrument will begin an automatic counting period. Before the end of this period, turn the FUNCTION switch to SCAN and begin timing a period equal to the total counting time desired less one automatic counting period. For example, if the total counting time desired is 60 seconds (twelve five-second periods), the interval to be timed is 55 seconds.

(4) At the end of the period being timed, turn the FUNCTION switch back to E/UT X N. When the instrument stops counting, read the indication.

2.6 "INPUT/N" OPERATION

What Kind of Measurement is Made. With the FUNCTION switch at INPUT/N, the instrument divides the frequency at the input jack by the number to which the digital divider switches are set, then counts cycles of the resulting lower frequency signal. For example, with a 10 kc input signal and the divider switches at "0250", the instrument would count cycles of a 40 cps signal.

Since the output of the digital divider is available at the TIME jack, the instrument also functions as a preset controller, delivering an output pulse each time N cycles occur at the input jack. The output consists of negative pulses, approximately 3 v. high and 12 μs wide out of 100 ohms, capacitively coupled to the jack.

Operating Characteristics.

Range of N: Any number from one to 9,999.

Length of Counting Period: Indefinite. Operator moves a switch to start and stop the counting process.

Operating Procedure.

(1) Couple a signal to the input jack and adjust ATTENuation and TRIGGER VOLTAGE controls as described in section 2.10, "Input Adjustments".

(2) Place the FUNCTION switch at OFF and press the RESET button. (The SLOPE switch may be at either position.)

(3) Set the digital divider switches (labeled N) to the number by which the input frequency is to be divided.

(4) Rotate the FUNCTION switch to INPUT/N to start counting.

(5) Turn the FUNCTION switch to OFF to halt counting. Counting may be resumed without clearing the accumulated count indication by turning the switch back to INPUT/N.

(6) To clear the registered count, press the RESET button.

2.7 "PERIOD X N" OPERATION

What Kind of Measurement is Made. With the FUNCTION switch at PER X N the instrument operates as a timer. It times the interval between the first voltage excursion through a selected level at the input and the Nth following excursion of the same polarity, where N is the number set on the digital divider switches. For example, assume that the input is a cyclic signal, the divider switches are set at "1000" and the SLOPE switch is set to "+". Under these conditions the instrument begins registering time at the first positive input excursion, continues timing for 999 additional excursions, and stops timing at the 1000th positive excursion. The count indication then shows the time elapsed while 1000 input cycles have occurred, and is thus 1000 times the average period of the input signal.

Operating Characteristics.

How Events are Represented: All events must be represented by voltage excursions of the same polarity applied to the input jack.

Range of N: N may be any number from one to 9,999.

Units in Which Measurement Appears: Choice of milliseconds, tenths of a millisecond, hundredths of a millisecond or (with Model 7161 only) microseconds.

Maximum Repetition Rate of Events: 10,000 events per second.

Maximum Measurable Interval: Model 7151: 99.999 seconds
Model 7161: 999.999 seconds

Accuracy: Accuracy depends somewhat on the amount of noise on the input signal. With a noiseless input signal, the possible error is ±one time unit ±accuracy of crystal oscillator frequency. With a large N (1000 for example), noise will not affect the accuracy appreciably.

Operating Procedure.

(1) Place the FUNCTION switch at PER X N.

(2) Set the digital divider switches (labeled "N") to the number of cycles to be timed.

(3) Set the TIME MILLISECONDS switch to the time unit in which the measurement is to appear.

(4) Position the SLOPE switch to trigger on either the positive-going (+) or negative-going (-) portions of the input waveform. Choose the steeper of the two slopes if there is any difference.

(5) Couple a signal to the input jack and adjust the ATTENuation and TRIGGER controls as described under "Input Adjustments", section 2.10.

2.8 "TIG" (TIME INTERVAL GENERATOR) OPERATION

What the Instrument Does. With the FUNCTION switch at TIG the instrument does not operate as a measuring device. Instead, the clock-pulse generator drives the digital divider which produces pulses for external use. The pulse interval is precise and may be varied over a wide range. The pulses appear at the TIME jack located at the rear of the instrument. The pulse interval will be equal to the TIME MILLISECONDS setting (0.1 or 1.0 ms) multiplied by N, the number to which the digital divider switches are set. This makes it possible to obtain pulse intervals ranging from 0.1 to 1000 milliseconds in steps of a tenth of a millisecond and from 1000 ms to 9999 ms in steps of one millisecond. The .01 and .001 positions of the TIME MILLISECONDS switch cannot be used during this operation.

Operating Characteristics.

Length of Pulse Interval: May be varied from 0.1 to 1000 ms in steps of one-tenth of a millisecond. May be varied from 1000 ms to 9999 ms in one-millisecond steps.

Accuracy of Pulse Interval: Possible error is equal to accuracy of crystal oscillator frequency.

Character of Pulses: The signal at the TIME jack will consist of negative pulses approximately 12 μs wide and approximately 3 volts high. The output impedance is approximately 100 ohms. Because the jack is capacitively coupled to the pulse-forming circuitry, there

is no DC output level. The leading negative transient has a faster rise time than the positive recovery transient. It is recommended that the negative transient be used when a highly accurate time standard is required.

2.9 "DELAY" OPERATION

In this mode, the instrument acts as a time delay generator. It provides a variable time delay ranging from 0.1 to 1000 ms in steps of 0.1 ms and from 1000 to 9,999 ms in steps of 1 ms.

Operation is similar to that of "TIG". In this case, however, a single output pulse appears at the TIME jack after a "start" signal has been applied to the input jack and the preselected interval has elapsed. The time interval is produced by the clock pulse generator driving the digital divider. The clock pulse generator also drives the indicating DCU's so that the time delay will be displayed.

Accuracy. Although the maximum possible timing error is 0.1 ms or 1 ms, depending on the setting of the TIME MILLISECONDS switch, the DCU indicators will always show the actual time delay obtained to within ±10 microseconds on the Model 7151 and ±1 microseconds on the Model 7161.

Operating Procedure.

(1) Set the FUNCTION switch to DELAY.

(2) Set the digital divider switches (labeled N) and the TIME MILLISECONDS switch for the required time delay. The delay interval will be equal to the TIME MILLISECONDS setting (0.1 or 1.0 ms) multiplied by the number to which the divider switches are set.

(3) Apply a "start" signal to the input jack. The SLOPE switch may be set to either "plus" (+) or "minus" (-), depending on whether the positive-going or negative-going part of the start signal is to begin the delay.

(4) At the end of the delay period, an output pulse will appear at the TIME jack at the rear of the instrument, and the time delay will be displayed by the DCU indicators.

2.10 INPUT REQUIREMENTS AND ADJUSTMENTS

2.10.1 Function of Controls. Three controls influence the action of the signal introduced at the input jack: the ATTENuation control, the TRIGGER control, and the SLOPE switch.

The attenuator divides the input voltage by the factor to which the ATTENuation control is set. With this control on the "DC" side the signal is direct-coupled to the trigger circuitry; in which case the circuit will trigger regardless of how slowly the input voltage changes. With the ATTENuation control on the "AC" side, the input signal is capacitively coupled to the trigger circuits; in this case the input frequencies must be 5 cps or higher, unless the input signal is strong enough to overcome the attenuating effect of the coupling capacitor.

The TRIGGER control varies the instantaneous voltage at which the attenuated signal triggers the input circuit. This critical voltage may be varied continuously from -1 v to +1 v.

The position of the SLOPE switch determines whether a positive-going or a negative-going input excursion will trigger the pulse which affects succeeding circuitry. For operations other than PER X N, this control may be at either position.

2.10.2 Routine Adjustment Procedure. When the input is an AC signal with a frequency above 5 cps, follow the step-by-step procedure given below. This procedure will result in successful operation in nearly all cases.

(1) Couple a signal to the input jack.

(2) Set the digital divider switches to "0001".

(3) Place the FUNCTION switch to OFF, then turn it to INPUT/N.

(4) Rotate the TRIGGER VOLTAGE control slowly from one extreme to the other while the ATTENuation control is at each of the three settings on the AC side. Note that the instrument will count steadily over a certain range of the TRIGGER control for each ATTENuation setting. Choose the highest ATTENuation setting at which counting will continue when the TRIGGER control is rotated through at least 45 degrees.

(5) Position the TRIGGER control at the midpoint of the arc throughout which counting occurs.

3. SERVICING

WARNING:

210 volts DC is present on the terminals of the four digital divider switches, located behind the front panel on the left-hand side. This voltage is capable of delivering a severe electrical shock: therefore, be careful not to touch these switches when making any of the adjustments described below.

3.1 ADJUSTMENTS

3.1.1 All adjusting controls and test jacks can be exposed to view by removing the lid of the cabinet. A few controls may be located on the rear panel. An identifying label appears near each control or jack. These labels appear in capital letters in the directions below.

CAUTION:

Removing the cabinet lid impairs the forced draft ventilation system. Therefore, to avoid overheating, do not permit the instrument to operate very long with the lid removed.

3.1.2 How to Adjust the Regulated B+ Supply. Adjust the "120V ADJUST" control (located at the rear of the instrument) until the voltage at the "120V" test jack (located on top near the back of the chassis) is +120 volts with respect to ground. The adjustment should be accurate to within ±3%. The line voltage while this adjustment is being made should be either the average line voltage at which the instrument will be operated or exactly 117v. In either case the adjustment will hold for line voltage variations of ±10%.

3.1.3 Oscillator Frequency Control. This is a screwdriver adjustment control labeled "XTAL ADJ." Rotating it varies the oscillator frequency slightly. On Model 7151 the 100 kc oscillator frequency has been adjusted to within 1 part in 10^6 at the factory; on Model 7161 the 1 mc frequency has been adjusted to within 1 part in 10^7. Do not disturb the control unless a frequency standard at least as accurate as the original setting is available. If a standard frequency signal is available, use it to form a Lissajous pattern with the oscillator signal which appears at the FREQuency jack. Couple the signal at the FREQ jack to the vertical input of a scope. Be sure the scope input impedance is not less than 10 megohms in parallel with 15 $\mu\mu$f; otherwise, the oscillator may be loaded enough to change its frequency slightly. Then, couple the standard frequency to the horizontal input and adjust the XTAL ADJ for a Lissajous pattern indicating equal frequencies.

3.1.4 Shaper Trigger Level Control. This is a screwdriver adjustment control located on top of the oscillator subchassis and labeled "SHAPER LEVEL". To adjust, position the FUNCTION switch at TEST. Find the limits of the range of adjustment over which the instrument continues to count. Set the control at the center of this range.

3.1.5 Multivibrator Frequency Divider Controls. (Labeled 10^{-3} SEC., 10^{-4} SEC., and 10^{-5} SEC.) The position of these controls determines whether the dividers will divide correctly (by 10) or incorrectly (by 9 or 11). The controls should be adjusted whenever the instrument fails to give a correct indication when tested for proper operation using the TEST position of the FUNCTION switch.

The regulated B+ voltage during adjustment should be +120 v. ±3%. Check this power supply voltage and, if necessary, readjust as described in section 3.1.2.

Each divider control should be adjusted while measuring the DC voltage at the red test jack adjacent to it. Rotate each control back and forth to the extremes of the range in which a correct count indication appears, noting the test jack voltage at each extreme. Then position the control so that the test jack voltage is midway between the extreme values. Follow Table V.

Table V. Adjustment of Frequency Dividers

	Model 7151			Model 7161		
	Set TIME Switch at	Adjust	Correct Count Indication	Set TIME Switch at	Adjust	Correct Count Indication
Step 1	0.1	10^{-4} SEC	10	.01	10^{-5} SEC.	10
Step 2	1.0	10^{-3} SEC	100	0.1	10^{-4} SEC	100
Step 3	-	-	-	1.0	10^{-3} SEC	1000

For example, step 1 when adjusting the Model 7151 should be done as follows:

Place the FUNCTION switch at TEST and the TIME MILLISECONDS switch at 0.1. Measure the DC voltage with respect to ground at test jack E4 near the control labeled 10^{-4} SEC. Rotate the control until the count indication changes from "10" to "9" and note the test jack voltage at this point. Then, rotate the control in the opposite direction until the count indication changes from "10" to "11", noting the test jack voltage at this point also. Finally, position the control at a point where the test jack voltage is halfway between the values noted. For example, if the voltage reading was +72 v. as the count indication changed from "10" to "9" and +94 v. as the indication changed from "10" to "11", set the control so the test jack reading is +83 v.

3.1.6 Trigger Voltage Control for Time Trigger Circuit. This control exists only on the Model 7161. It is a screwdriver control labeled "TIME TRIGGER LEVEL". The control varies the instantaneous input voltage at which the Time Pulse Trigger circuit (V601) switches states. Do not disturb the setting unless absolutely necessary. When necessary, adjust as follows. Position the TIME MILLISECONDS switch at .001. With the FUNCTION switch at TEST, adjust the control until the instrument shows a count indication of "1". Then, move the TIME MILLISECONDS switch to .01, 0.1 and 1.0 sucessively, observing the count indications at these positions. If incorrect indications appear, readjust the control until a correct indication appears at all four positions.

4. CIRCUIT DESCRIPTION

4.1 GATE AND CONTROL CIRCUITRY

(Refer to dwg. 7151 D 1, and 7161 D 2.)

The Gate and Control Circuitry receives three pulse inputs from the FUNCTION switch (S201): pulses to be counted, start pulses and stop pulses. Pulses to be counted go from Deck G to the signal grid of the Gate tube (V204). The plate of this tube is coupled to the first of the cascaded DCU's. During the period its suppressor grid is at ground the tube amplifies the grid signal and drives the DCU's. In this state the Gate is "open". When the suppressor grid is below -10 volts, the tube is cut off and the Gate may be considered "closed".

The "open-close" voltages on the Gate tube suppressor gird are generated at the right plate of the Control Binary (V203). V203 is a conventional "flip-flop" circuit. Such a circuit has two stable states: left half conducting, right half cut off; and right half conducting, left half cut off. Input pulses or transients applied at various points on the circuit will trigger it back and forth between the two states. When the right half of V203 is conducting, the right plate is 30 volts negative. A negative start transient from the Start Binary, applied at the left plate of V203 and coupled through C210 to the right grid, triggers V203 to its other stable state. In this state the right half is cut off and the right plate rises above ground permitting the Gate tube to conduct. When a negative stop pulse from Deck E of the FUNCTION switch reaches the left grid of V203 through the diode CR212, V203 is triggered back to the state which holds the Gate closed.

The signals generated by V203 are also used to control the Input Gate (V701) and the Coincidence Gate (V702B) in the digital divider circuit.

The Start Binary is also a "flip-flop" circuit. It produces a negative start transient at its right plate each time that half begins to conduct. Its left grid is coupled to Deck C of the FUNCTION switch through the diode CR211 and C201. When the left half is conducting a negative start pulse at the grid triggers a change to the other stable state producing the output transient. Further negative pulses at the left grid have no effect since that half is already cut off.

When the instrument is ready to begin a counting period the right half of the Control Binary and the left half of the Start Binary are conducting and the Gate is closed. Negative stop pulses received at the left grid of the Control Binary have no effect since this half is cut off. The following sequence occurs. (Refer to Figures 3 and 4.)

At time "1" A start pulse passes through the injection diode CR211 and triggers the Start Binary which in turn triggers the Control Binary to a state which opens the gate. The DCU's then count and indicate the number of pulses reaching the Gate.

At time "2" A stop pulse triggers the Control Binary to a state which closes the Gate.

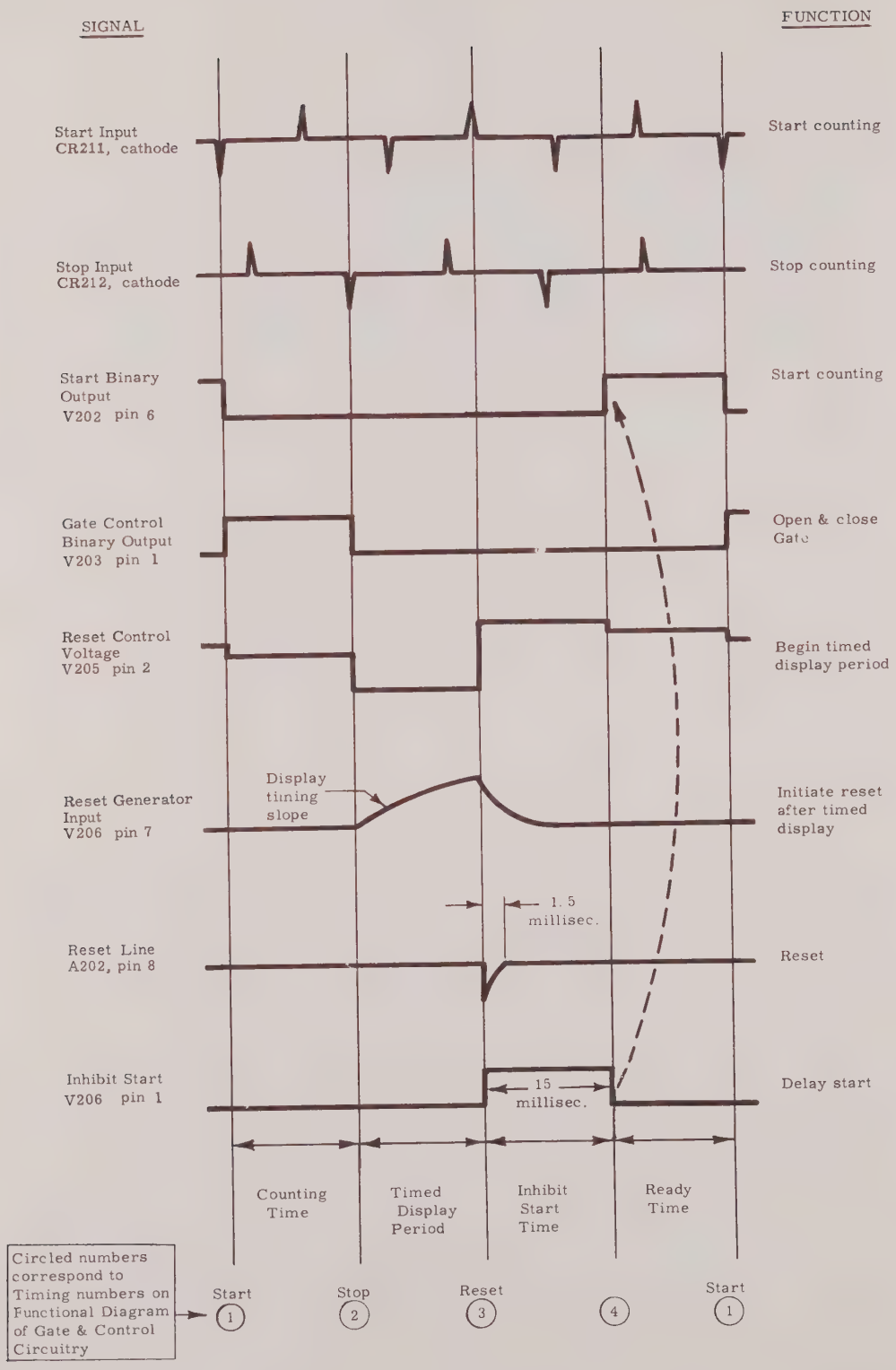
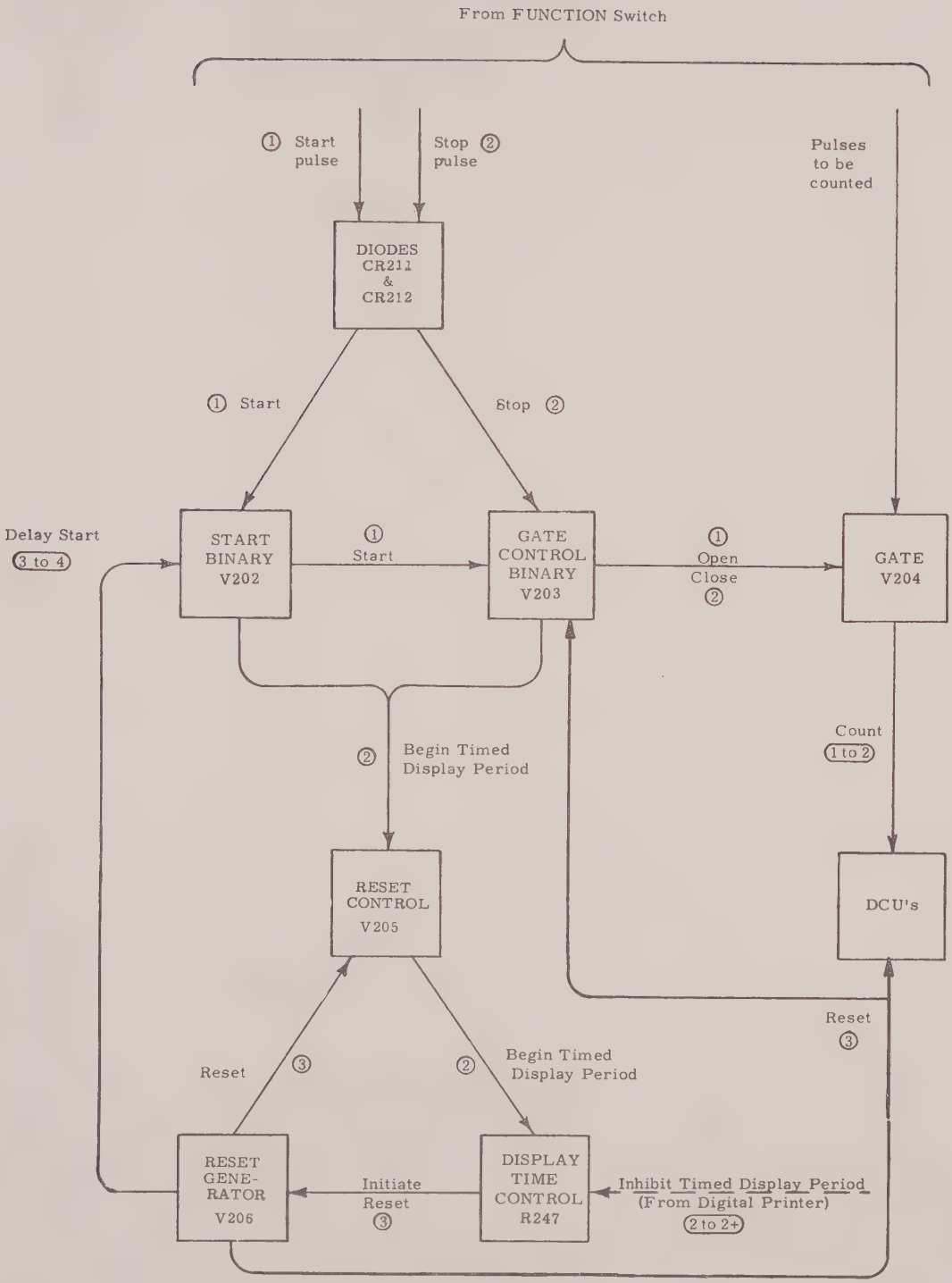


FIG. 3. Control circuit timing diagram when counter is not equipped with digital printer.



NOTE: Circled numbers indicate time of operation as labeled on the Timing Diagrams.

FIG. 4. Functional block diagram of gate and control circuits.

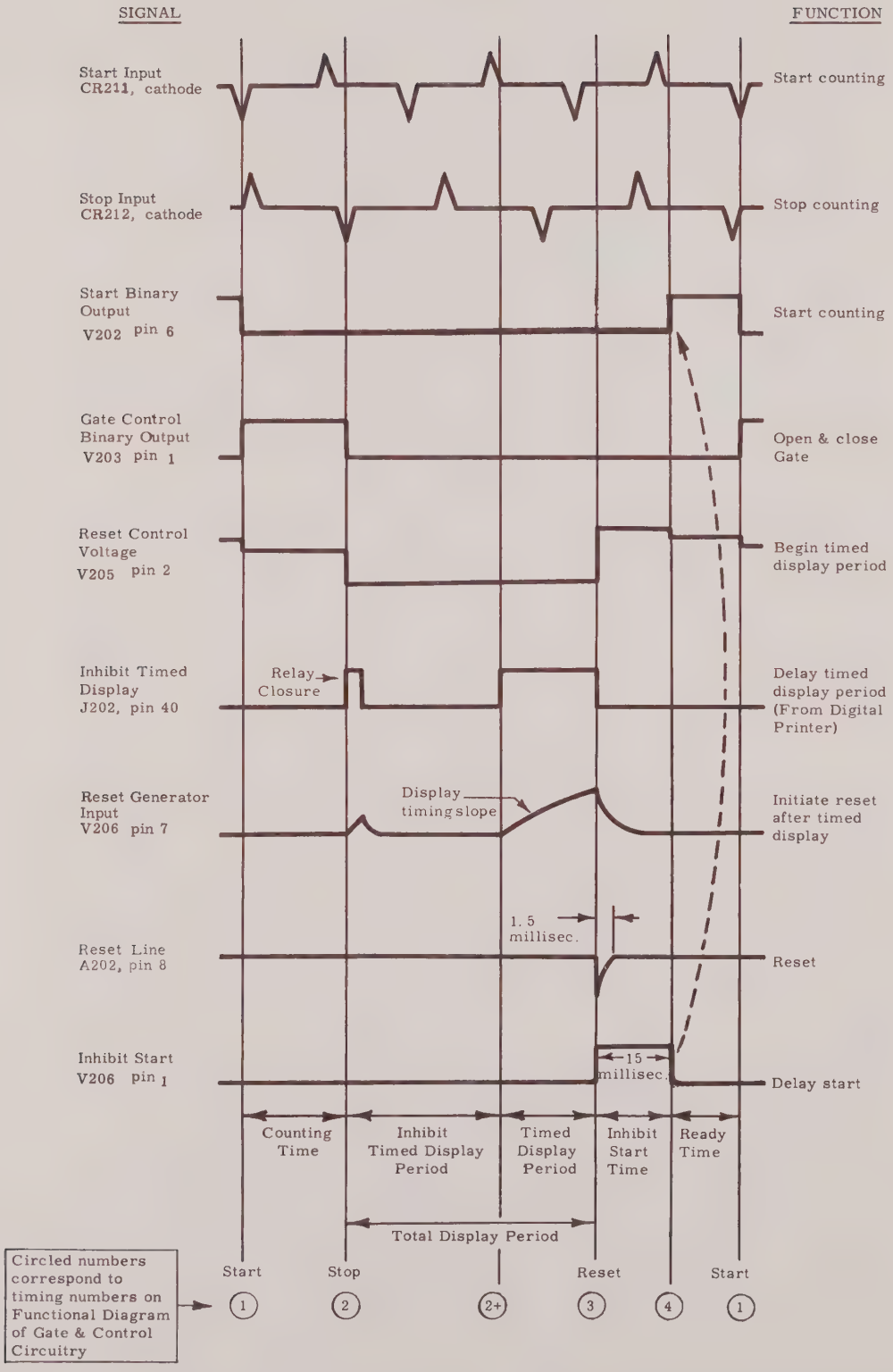


FIG. 5. Control circuit timing diagram when counter is equipped with digital printer.

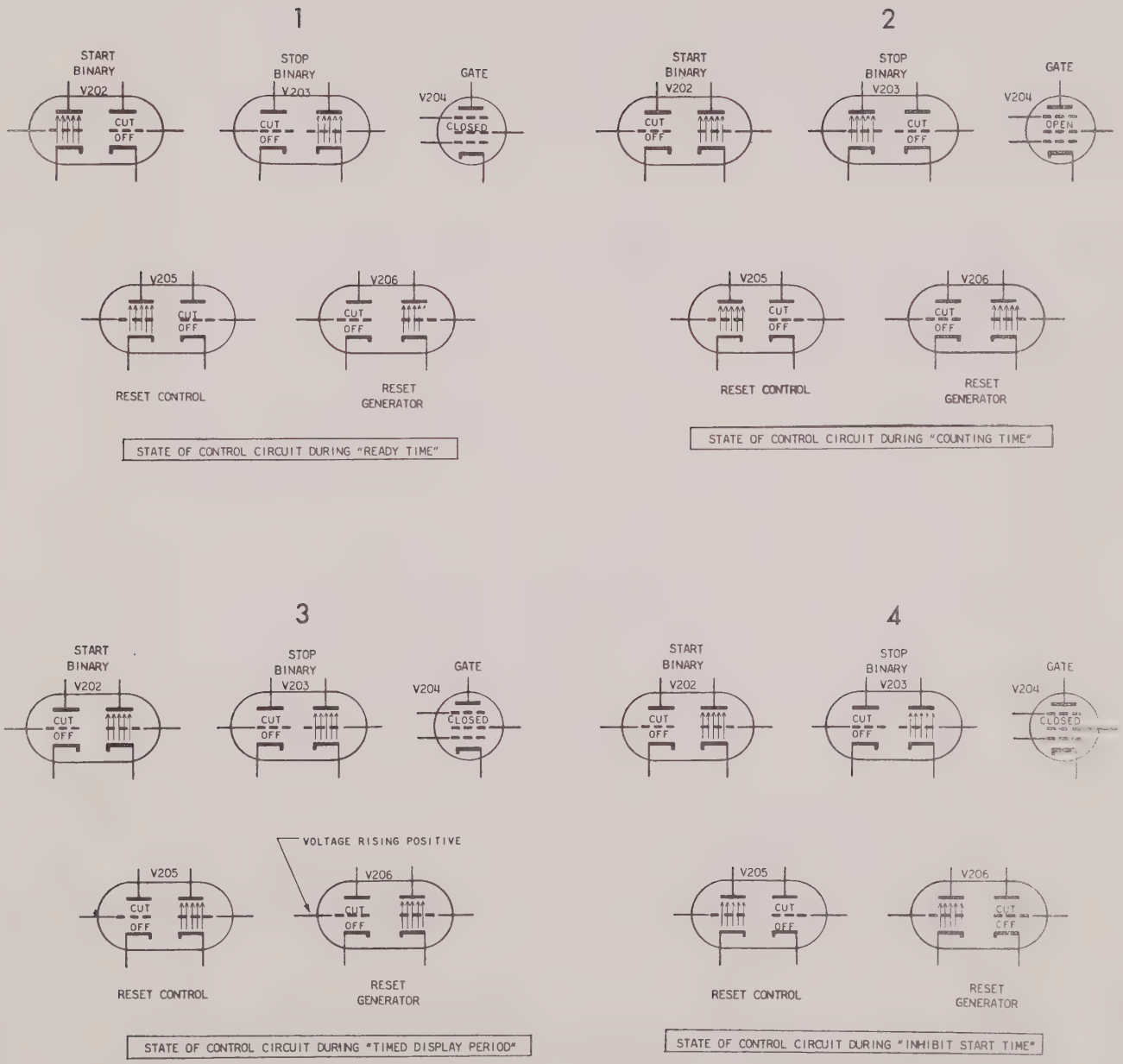


FIG. 6. State of the tubes in the gate and control circuits during an operating cycle.

At this point, if the instrument is set to operate automatically, the reset circuitry begins to function. The reset control voltage appears at the junction of CR201 and CR203. Its value is determined by the combined effect of the voltage on the right plate of the Start Binary and that on the right plate of the Gate Control Binary. At the close of a counting period (and only then) both these plates are negative. The resulting negative voltage at the junction is applied to the input grid of the Reset Control through R239.

This negative voltage biases the left-hand section of V205 to cutoff which, in turn, causes the right-hand section to conduct. The resulting rise in potential at the junction of resistor R248 and the DISPLAY time potentiometer (R247) causes capacitor C216 to discharge through R247. As the capacitor discharges, the potential at the input grid (pin 7) of the Reset Generator (V206) rises. The Reset Generator is a monostable multivibrator. In its stable state, the right-hand triode section is conducting while the left-hand section is cut off. When the potential on the left-hand grid becomes sufficiently positive, it triggers the Reset Generator to its quasi-stable state (i. e., left side conducting, right side cut off). This occurs at time "3", with the interval between time "2" and time "3" depending on the setting of the DISPLAY control (R247).

At time "3" then, the potential at the left-hand plate of the Reset Generator drops, while that at the right-hand plate goes up. The drop in voltage at the left-hand plate, coupled through a capacitor to the DCU reset line, produces a negative pulse which resets the DCU's. This same reset pulse also goes to the input grid (pin 7) of the Control Binary and triggers it to the "right side on" state. The rise in voltage at the right-hand plate of the Reset Generator is fed back to the input grid of the Reset Control. This causes it to return to its original state (i. e., left side on, right side off).

The Reset Generator remains in its quasi-stable state for 15 milliseconds. At the end of that period, time "4", the Reset Generator jumps back to its stable state (right side on, left side off), and the voltage on the right-hand plate drops. This drop in voltage is coupled through capacitor C203 and resistor R289 to the Start Binary, resetting it to the "left side on" state. The 15 millisecond delay provided by the Reset Generator keeps any start pulses from triggering the Start Binary, to initiate counting, until all reset transients have decayed.

When the Start Binary is reset, the potential on its right-hand plate goes up. The reset control line is clamped to this higher potential by diode CR201 so that the Reset Control (V205) will not be triggered at this time. The next start pulse triggers the Start Binary to its "right side on" state which, in turn, triggers the Control Binary to its "left side on" state. To prevent reset action at this time, diode CR203 clamps the reset control line to the relatively high positive potential at the right-hand plate of the Control Binary. The next stop pulse triggers the Control Binary to its "right side on" state, the potential at the right-hand plate drops, and the entire reset process is repeated.

NOTE

When the counter is equipped with the Model 1452 Digital Recorder, the sequence of operations described above is interrupted briefly. A relay in the recorder grounds the input to the DISPLAY time potentiometer from the end of the counting period (time "2") until the recorder has collected count information from the DCU's. (See Figure 5) The connection to the recorder is made through pin 40 of J202.

When the DISPLAY time control is turned fully clockwise the input connection to this potentiometer is broken by switch S204 and automatic reset will not occur. The DCU's hold the accumulated count until the RESET button is pressed. When this is done, the contacts of switch S205 are shorted, and a positive pulse is applied to the left-hand grid of the Reset Generator. This positive pulse triggers the Reset Generator, and causes it to produce a reset signal just as in automatic operation.

4.2 INPUT TRIGGER CHANNEL

(Refer to dwg. 7000 C 300)

The input trigger channel produces an output pulse each time the attenuated input signal passes a selected voltage level. The output is independent of input waveform. The channel consists of a Schmitt trigger voltage discriminator preceded by a two-stage comparator amplifier. Each input channel is preceded by an attenuator, which divides the input voltage by 1, 10 or 100 according to the position of the ATTENuation control. The input impedance at all positions is about 10 megohms in parallel with 40 $\mu\mu$f. When the ATTENuation control is at an AC position a .01 μf capacitor (C201) is inserted in series between the INPUT jack and the attenuator.

The comparator amplifier has two stages. The first is a difference amplifier whose output is proportional to the input voltage on the grid of V301A minus a selected constant voltage on the grid of V301B. The TRIGGER VOLTAGE potentiometer (R318) varies the voltage on the grid of V301B between -1 and +1 volts. The second stage (V302) amplifies the double-ended signal received from V301 and converts it to a single-ended low impedance output at the left-hand plate. This plate is connected to the input grid of the discriminator.

The voltage discriminator (V303) produces an output pulse each time the input voltage on its left-hand grid passes through a fixed voltage level (about +60 volts). Consider the input to this circuit as an AC triggering signal superimposed on a DC level. The AC signal is an amplified reproduction of the voltage variations on the grid of V301A, that is, the attenuated input. The DC level is determined by the voltage on the grid of V301B, a voltage set by the TRIGGER potentiometer. As the TRIGGER control is rotated toward "+", the DC level is lowered and the discriminator triggers at a higher instantaneous voltage of the AC signal and at a higher attenuated input voltage to the channel. When the TRIGGER control is turned toward "-", the channel triggers at a lower attenuated input voltage.

The discriminator (V303) is a two stage positive feedback amplifier. Feedback from the output stage occurs through the cathode coupling. The loop gain is slightly greater than one so that the circuit is regenerative and tends to assume one of two stable states. The output stage draws a steady current as long as the input grid remains below a certain triggering voltage. When the input exceeds this voltage the output tube is suddenly cut off. When the input voltage returns to a value slightly below the initial triggering voltage the output stage builds rapidly to its original steady current.

The difference between the level at which a positive-going voltage change triggers the circuit and the lower level at which a negative-going voltage change retriggers it is called the hysteresis of the circuit. At the input to the comparator amplifier the hysteresis is about 0.3 volts. The hysteresis determines the input sensitivity. An attenuated input signal weaker than 0.3 volts peak-to-peak or about 0.1 volts rms will not trigger a series of pulses. This means that any noise at the attenuated input below this level will not trigger extraneous pulses, although it may affect the time at which a pulse occurs.

The primary winding of T301, differentiates the rapid current changes in the output stage to produce a positive pulse at the plate when the circuit is triggered by a positive-going voltage and a negative pulse when triggered by a negative-going voltage. The secondary of T301 produces inverted pulses--a negative pulse when the circuit is triggered on a positive slope and a positive pulse when triggered on a negative slope.

4.3 OSCILLATOR AND SHAPER

(Refer to dwg. 7000 C 419.)

The oscillator circuit consists of two sections: a crystal controlled oscillator stage (V401A), followed by a buffer amplifier (V401B). The oscillator stage uses an oven-controlled crystal, and is adjusted with the temperature stable capacitor, C410, which can shift the frequency of oscillation by a few cycles per second. Capacitor C404 has a nominal value as shown on the schematic diagram, but is selected at the factory to allow capacitor C410 to adjust the oscillator to the correct frequency.

The output of the oscillator stage drives the buffer amplifier, a pentode with a tuned circuit plate load. A portion of the output from the buffer amplifier is fed back to the oscillator stage to increase the amplitude stability of the signal.

The shaper stage (V402) amplifies and shapes the oscillator output for use as an input to the control circuitry and the dividers. The circuit is a voltage discriminator which operates in the same way as that discussed under "Input Trigger Channels". The trigger voltage level is set by adjusting R414. L402 differentiates the rapid current changes at the output plate to produce fast positive and negative pulses. The negative transients drive the first divider and the pulse output goes to the TIME MILLISECONDS switch (where it may be

selected to drive the Time Pulse Trigger). The output also goes directly to the FUNCTION switch where it provides pulses to be counted during TEST operation and the start pulse for INPUT/N or TIG operation.

4.4 FREQUENCY DIVIDER CHAIN

(Refer to dwgs. 7151 C 3 and 7161 C 6.)

The divider chain is a series of cascaded monostable multivibrators. Each produces one output pulse for every ten input pulses. The Model 7151 has two dividers which scale its 100KC oscillator frequencey down to 1KC. The Model 7161 has another divider preceding the last two which scales its 1MC oscillator frequency down to 100KC. Although the 1MC divider (V603) has additional circuitry to provide for high speed operation, it functions in essentially the same way. The process will therefore be described with reference to V743.

With no input the circuit is stable; the right-hand side is conducting because its grid is connected to +120V DC and the left-hand side is cut off. A negative transient reaching the input capacitor (C745) is coupled through R752 and R753 to each of the two plates. The negative pulse produced on the left plate is coupled by C748 to the right grid. It appears as an amplified positive pulse at the right plate, which is coupled to the left grid through C746. The left-hand side of the tube conducts, driving the left plate and the right grid even further negative. This regenerative action produces a quasi-stable state in which the right side is cut off and the left side is conducting. In this state the voltage on the right grid (called the "timing grid") is rising relatively slowly as the voltage at the wiper of potentiometer R760 charges the timing capacitor (C748) through R757. At the same time, negative input pulses at the right plate reach the left grid through C746 and appear as large positive pulses at the left plate. These pulses reach the timing grid through C748 and appear superimposed on the rising voltage curve there. When one of the positive pulses brings the timing grid above cutoff, the right side conducts and a reverse regenerative action returns the circuit to its original stable state. The slope of the rising grid voltage curve determines which of the successive positive pulses will rise above cutoff. The slope changes when the charging voltage at the wiper of R760 is raised or lowered. R760 is adjusted so that the ninth pulse rises above cutoff. The tenth pulse returns the circuit to the quasi-stable state.

In the interval between the ninth and tenth pulses the right side is conducting and the right plate is negative. The negative transient produced is the useful output of the divider. It goes to the TIME MILLISECONDS switch where it is available as a clock signal.

The additional circuitry associated with the 1MC divider (V603) speeds up its response. V603 is a multivibrator which operates just as V743. V602A is a cathode follower inserted between the left plate of the multivibrator and the

timing grid. Its function is to discharge C606, the timing capacitor, within the brief 1 microsecond output pulse period so that the capacitor will pass the next positive pulse to the grid. V602B functions as a diode clamp on the left grid of the multivibrator. It prevents this grid from going so far negative during the 1 microsecond pulse output period that it will not rise above cutoff when the next positive pulse reaches it.

On the Model 7161, the TIME MILLISECONDS switch selects a negative output transient from one of the divider stages and feeds it to the Time Pulse Trigger (V601). The Time Pulse Trigger is a voltage discriminator which operates in the same way as that described in section 4.2, "Input Trigger Channel". Output clock pulses produced at L601 are coupled to the FUNCTION switch.

4.5 SELECTIVE DIGITAL DIVIDER

(Refer to dwg. No. 7151 D 2)

The digital divider consists of the circuitry shown in block form in Figure 7. In the following discussion the counter is assumed to be set up for E/UT X N operation

In this mode of operation, the input signal whose frequency will be divided consists of clock pulses with the pulse interval indicated by the TIME MILLISECONDS switch. Another input to the divider is a signal from the gate control binary (V203). This is the same signal which opens and closes the gate (V204) through which pulses pass to the indicating DCU's. The purpose of the digital divider during this operation is to extend the counting period by some multiple of the clock pulse interval. It will be assumed that the digital divider switches are set to "1000", which means that the counting period will be 1000 times the clock pulse interval. The process is then as follows:

(1) During the display period, clock pulses reach the Digital Divider Drive (V207). They are amplified and shaped, and then applied to the Divider Input Gate (V701) as well as the Coincidence Gate (V702B). At this time, however, both these gates are held closed by the signal from the Control Binary (V203).

(2) A reset pulse resets the indicating DCU's to a registered count of zero and, at the same time resets the digital divider to a registered count of one (0001).

(3) A clock pulse (which will be called "clock pulse No. 1") actuates the gate control circuitry, thus flipping the Control Binary. The Control Binary opens gate V204, allowing the indicating DCU's to begin counting. Clock pulse No. 1, however, does not pass through either gate in the digital divider, because the signal from the Control Binary is delayed long enough to hold both these gates closed until the pulse has subsided.

(4) Clock pulse No. 2 passes through the Divider Input Gate (which is now open) causing the digital divider to tally one count. The divider now has a registered count of 0002. However, this pulse does not pass through the Coincidence Gate because this gate will remain closed until the registered count on the divider DCU's coincides with the number to which the switches are set (which in this case is "1000").

(5) The digital divider continues to be driven by clock pulses Nos. 3 through 1000. After pulse No. 1000, the divider has a registered count of 1000, and the coincidence gate is open.

(6) Clock pulse No. 1001 passes through the coincidence gate and triggers the Blocking Oscillator, V702A. The Blocking Oscillator generates a "stop" pulse which, applied to the gate control circuitry, closes the gate admitting pulses to the indicating DCU's and thus stops the counting action. Notice that the elapsed time between clock pulse No. 1, which initiated the counting period, and clock pulse No. 1001, which ended the counting period, is equal to 1000 pulse intervals.

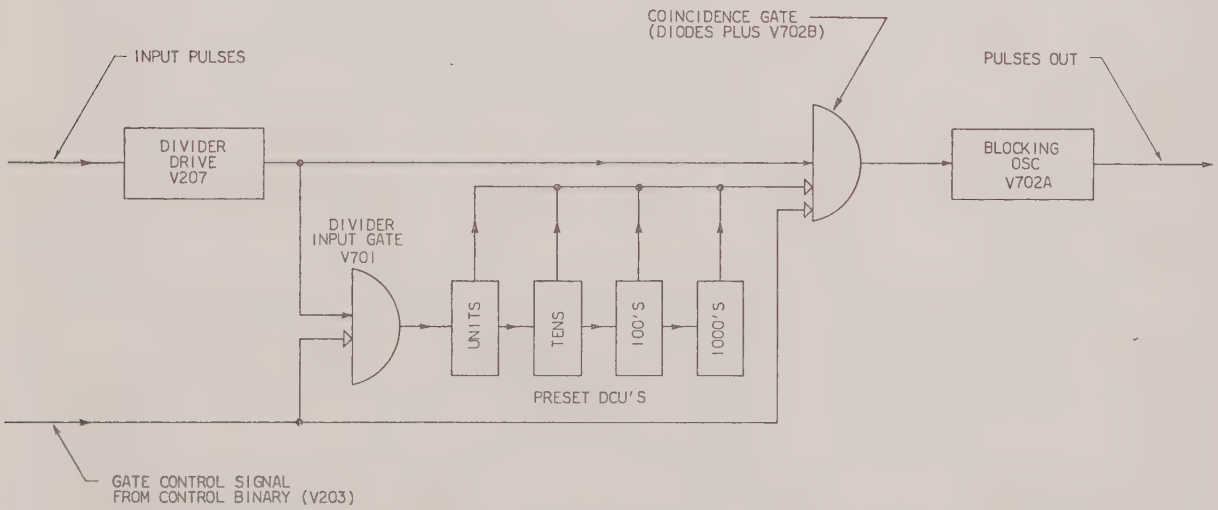


FIG. 7. Block diagram of the selective digital divider.

The preset switch (S701) applies +210 v DC through a one megohm resistor to all coincidende diodes except those in the readout lines which will be positive of ground when the DCU is registering the preset digit. When the DCU is not registering the preset digit, at least one diode will be in a readout line which is negative of ground. Current drawn through this diode and through resistor R705 lowers the voltage at the coincidence bus to approximately -15 v DC. This voltage, applied to the grid of V702B, holds this grid well below cutoff so that pulses from C704 cannot cause the tube to conduct. When all DCU's are registering the digit preset on each, all the coincidence diodes are connected either to a readout line which is positive of ground or to the +210 v DC supply. Under these conditions the coincidence bus goes positive up to ground level, where it is clamped by CR702. With the grid of V702B biased at ground potential, a positive pulse from C704 rises above cutoff, causing V702B to conduct and triggering Blocking Oscillator V702A.

The Blocking Oscillator generates a 12 microsecond, -200 volt pulse at its plate. This signal supplies a -100 volt pulse for resetting the DCU's in the digital divider, and a 2 volt negative pulse across a 100 ohm resistor at the TIME jack. The same signal is also coupled to a pulse transformer (T280) which generates 0.5 microsecond positive and negative pulses for use elsewhere. The negative pulses are used to trigger the Control Binary and the positive pulses are counted by the indicating DCU's when the unit is used as a totalizer.

The Blocking Oscillator resets the DCU's in the digital divider but does not reset the indicating DCU's. However, the RESET button will reset the DCU's in the divider as well as the indicating DCU's. This enables the operator to stop the divider DCU's manually at any time.

4.6 POWER SUPPLY

(Refer to dwg. 7370 C 100)

A conventional system consisting of a transformer, two selenium bridge rectifiers and a filter network produces the +200 and -110 volt unregulated supply. Ripple on these supplies is about 10%.

The regulated +120 volt supply is obtained by dropping 200 volts through V102. The voltage drop across V102 is controlled by V101 in such a way as to maintain a constant voltage at the regulated output. A voltage dividing network (R106, R107, R113) is connected between the regulated supply and a point held 60 volts negative of ground by a diode (CR106). The control grid of V101 is connected to a point on this network which is slightly below ground when the regulated supply is 120 volts. When the regulated supply varies from 120 volts, the voltage on the control grid varies proportionately and V101 delivers a signal to V102 which opposes the change.

NOTE

Modified instruments are identified by one or more letters after the model number, each letter standing for one of the modifications described below. For example, Model 7150DR is a standard 7150 that has been modified to incorporate an oven-controlled crystal instead of an unheated crystal (Modification D) and is fitted for rack mounting (Modification R). Some modifications in this section may not appear in alphabetical order.

MODIFICATION B

Modification B extends the count capacity by a factor of 10 or divides the frequency of the start and stop pulses by 10.

Models 7151, 7351, 8151, and 8351

A Model 775Z DCU, A705, is placed between the Divider Input Gate, V701, and DCU A704. When switch S206 is in the "N X 10" position, A705 divides the digital divider drive pulses by 10, raising the maximum input frequency from 10 kc to 100 kc. In the "N X 1" position, the instrument works as if unmodified. The circuit changes are shown in Figure B.

Other Models

The schematic diagrams of the other instruments for which modification B is available show the modified circuitry.

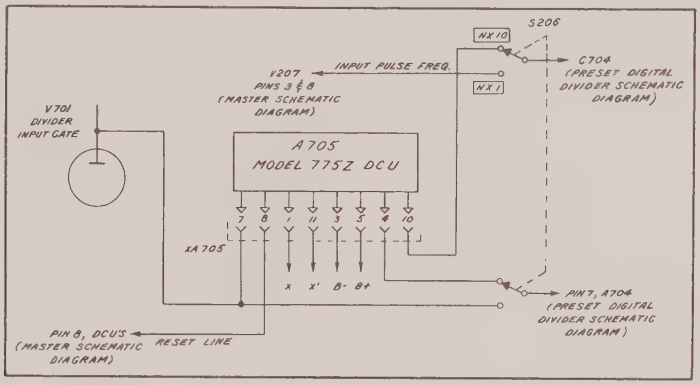

S206
NX10
NX1
INPUT PULSE FREQ.
V207 PINS 3 & 8 (MASTER SCHEMATIC DIAGRAM)
C704 (PRESET DIGITAL DIVIDER SCHEMATIC DIAGRAM)
V701 DIVIDER INPUT GATE
A705 MODEL 775Z DCU
7 8 1 11 2 5 4 10
XA705
X X' B- B+
PIN 7, A704 (PRESET DIGITAL DIVIDER SCHEMATIC DIAGRAM)
PIN 8, DCU'S (MASTER SCHEMATIC DIAGRAM)
RESET LINE

FIGURE B CIRCUIT CHANGES FOR MODIFICATION B IN MODELS 7151, 7351, 8151 AND 8351

MODIFICATION C

An instrument with modification C has a mechanical register that extends the count capacity by three extra digits. The register coil is the plate load of a one-shot multivibrator, V21, driven by the output signal of DCU A202; thus, the register records one count for every output pulse of the DCU.

The register is reset manually by a small lever on the front panel just below the register dials and is not affected by the electronic signal that resets the DCU's.

In C-modified instruments with "X 10" modes of operation, the count-indicating panel of the DCU Divider, A201, is not exposed to view, and the digit normally displayed by A201 appears as the right-hand digit of the register.

When A202 resets, it may give an output pulse. To stop this from registering, the reset line is connected to the control grid, pin 2, of V21 so that the inverted reset pulse appearing at the plate, pin 1, supresses the false count.

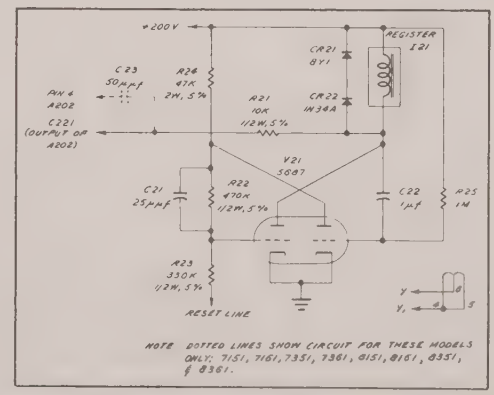


FIGURE C CIRCUIT OF MODIFICATION C

MODIFICATION D

The frequency stability of the clock pulse generator in instruments using an unheated crystal is 1 part in 10^5 per day. Modification D substitutes a temperature-controlled crystal for the unheated type and improves the oscillator stability to 1 part in 10^6 per day.

Power for the heating element in the crystal oven is taken from one of the filament circuits in the instrument (the circuit that has one side grounded).

The circuitry is shown on the crystal oscillator schematic diagrams of the instruments concerned.

MODIFICATION H

Instruments with this modification have a power transformer with a 222-volt primary instead of the standard 117-volt, the primary being two windings in series, a 117-volt and a 105-volt. The line fuses, F101 and F102, have one-half the current rating of those in the standard instruments. Figure H-1 shows the modified circuitry. Note that in instruments with a 1 mc heated crystal in the oscillator, the crystal oven no longer begins heating as soon as the line cord is plugged into a power receptacle, but heats only when the POWER switch is on.

If operation on 210 volts or 231 volts is desired, take the wire off terminal 2 of the transformer and connect this wire to terminal 14 or 11 respectively.

To convert to 117-volt operation, rewire the transformer connections as shown in Figure H-2 and replace F101 and F102 with fuses of twice the current rating. The correct current rating is listed on the power supply schematic diagrams of the instruments.

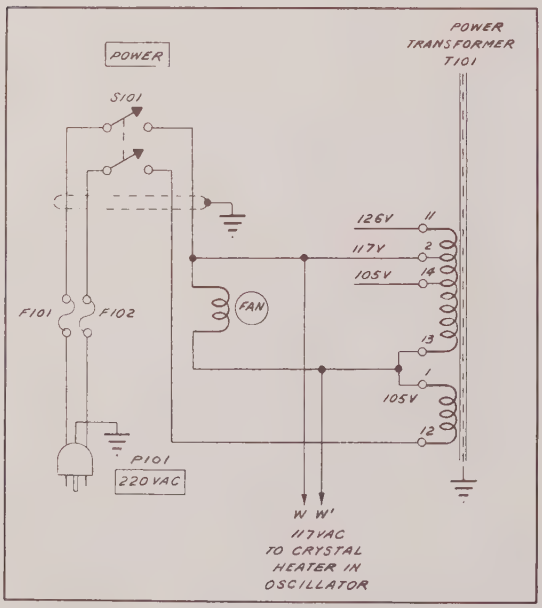


FIGURE H-1 CIRCUIT CHANGES IN POWER SUPPLY FOR MODIFICATION H

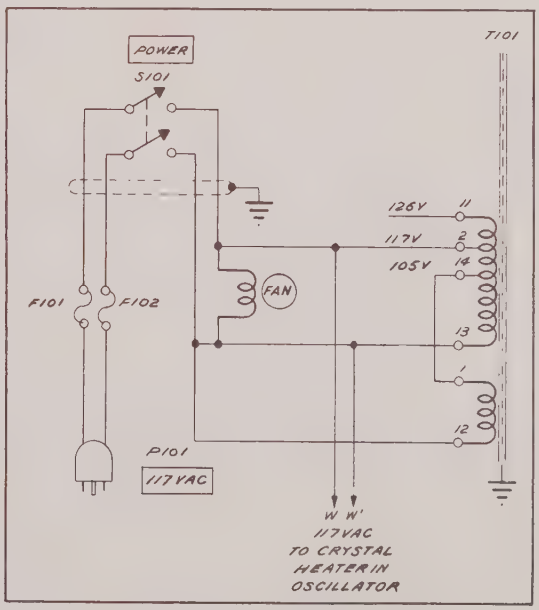


FIGURE H-2 REWIRING MODIFICATION H TO OPERATE ON 117 VOLTS AC

MODIFICATION J

Modification J raises the maximum counting rate of 100 kc instruments to 220 kc, and 1 mc instruments to 2.1 mc.

100 kc Instruments

DCU A206 is replaced by a 220 kc DCU, Model 713AH, and the circuitry of the instrument is modified to suit the new unit as shown in Figure J-1.

1 mc Instruments

a) DCU A207 is replaced by a 711AH, and A206 by a 713AH. Each of these DCU's has about double the counting speed of the unit it replaces. The plate load of the Gate Control tube in the instrument is changed and the circuitry immediately associated with the new DCU's is modified as shown in Figure J-2.

b) In addition, any input channels required to operate between 1 mc and 2 mc in count modes are supplanted by faster channels with a cathode-follower between the comparator amplifier and the voltage discriminator. These 2 mc input channels are shown in Figure J-3 (A or B channels, where appropriate) and Figure J-4 (C channel only).

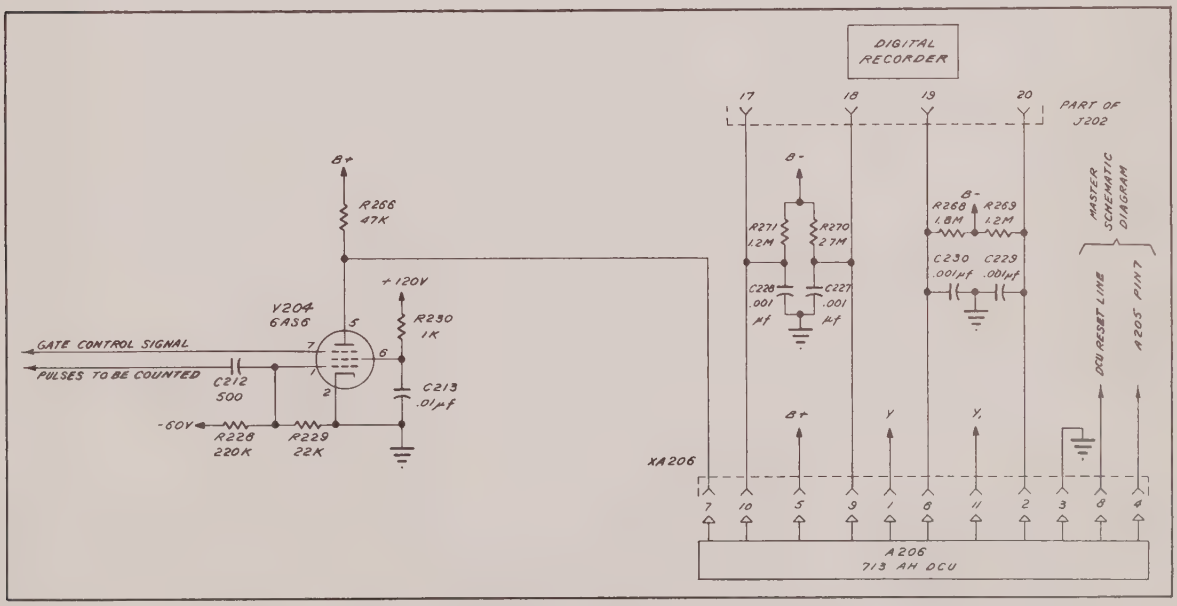


FIGURE J-1 100 KC INSTRUMENT MODIFIED FOR 200 KC OPERATION

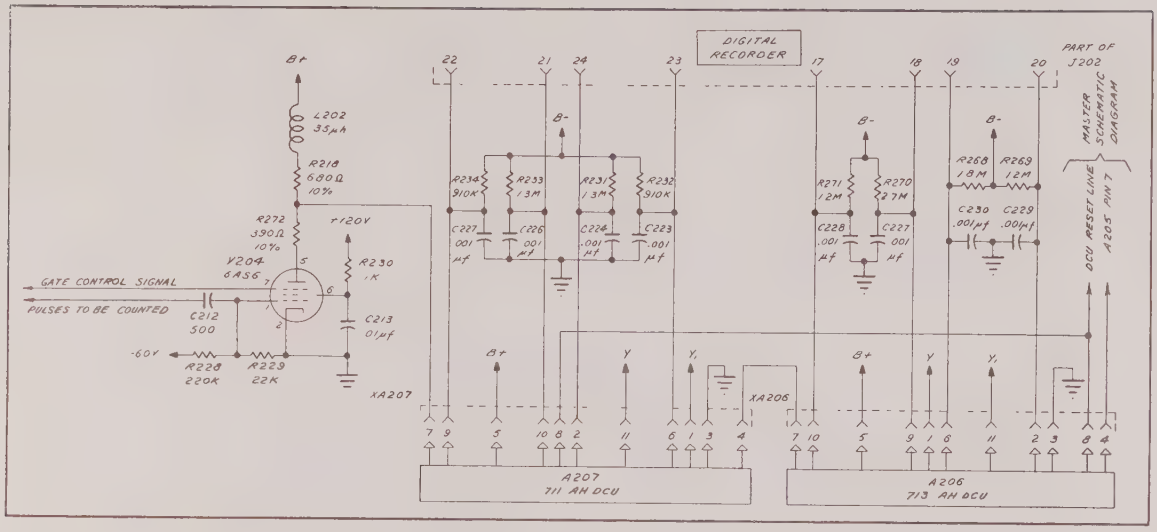


FIGURE J-2 1 MC INSTRUMENT MODIFIED FOR 2 MC OPERATION

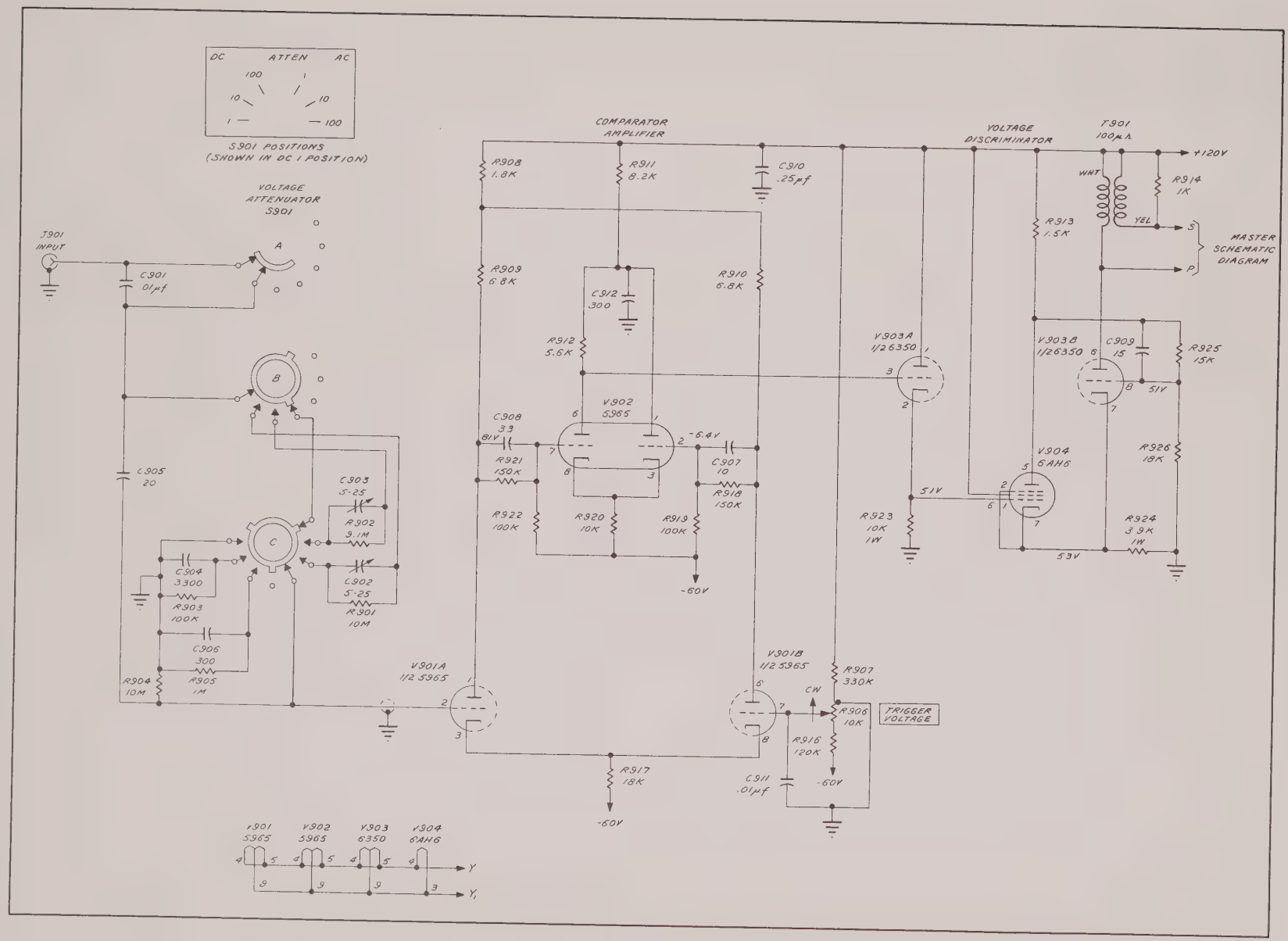


FIGURE J-3 A OR B INPUT CHANNEL IN 2 MC J MODIFICATION

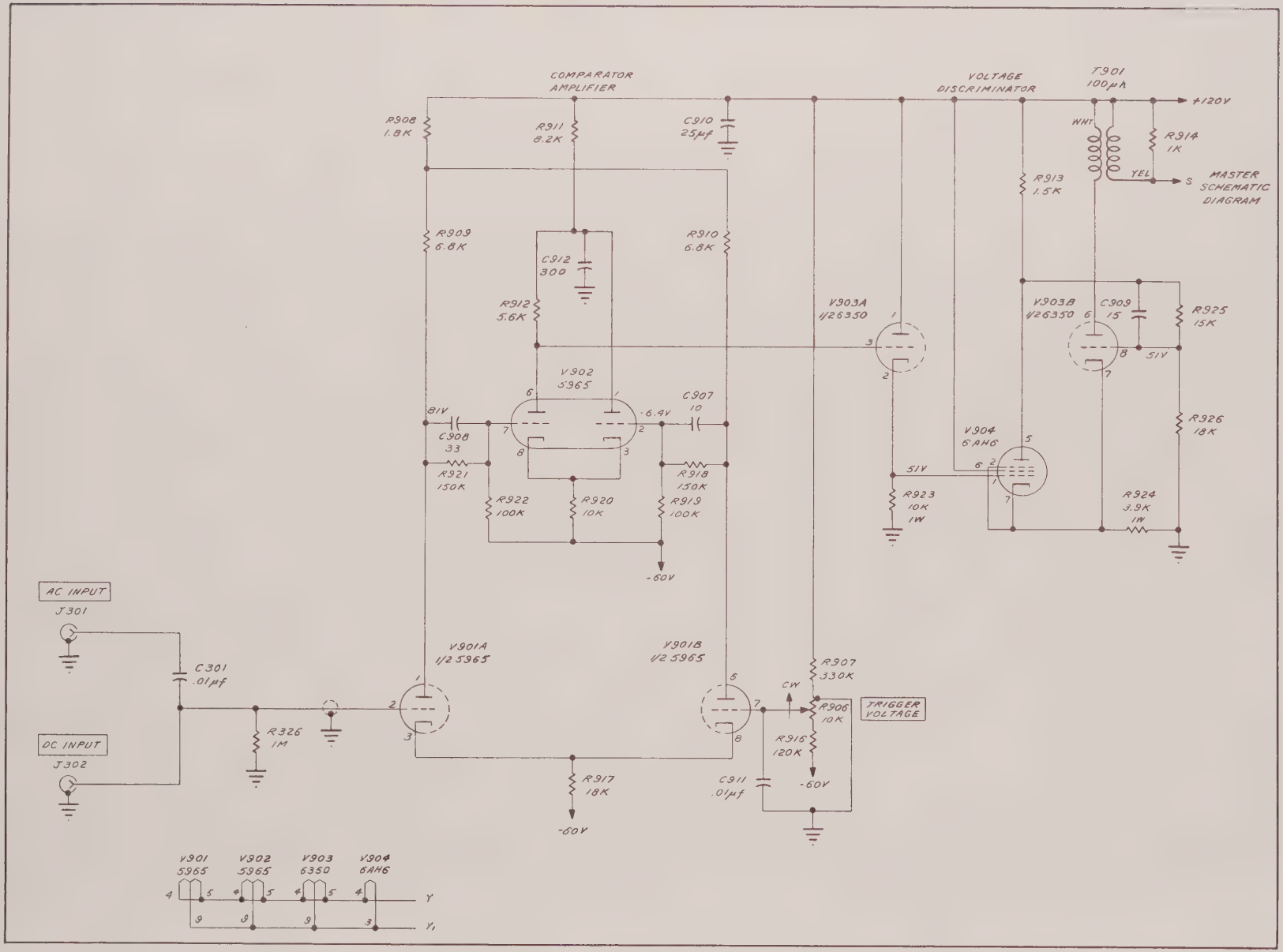


FIGURE J-4 C INPUT CHANNEL IN 2 MC J MODIFICATION

MODIFICATION K

To increase the input sensitivity of a counter from 100 mv rms to 5 mv rms, a step-up transformer is inserted between the attenuator and the first grid of any input channel used in count modes. The transformer is put in or out of circuit by a front panel switch (S350) marked HIGH (transformer in) and NORM (transformer out and attenuator connected straight through to the first grid). It should be switched in only if the input signal is below the sensitivity of the counter.

With the transformer connected, the ATTENUATION control should be at DC-1. Under these conditions the input impedance will vary with frequency, rising from at least 300 ohms at 5 cps to about 25K ohms at 10 kc. Sensitivity is at least 5 mv over this range.

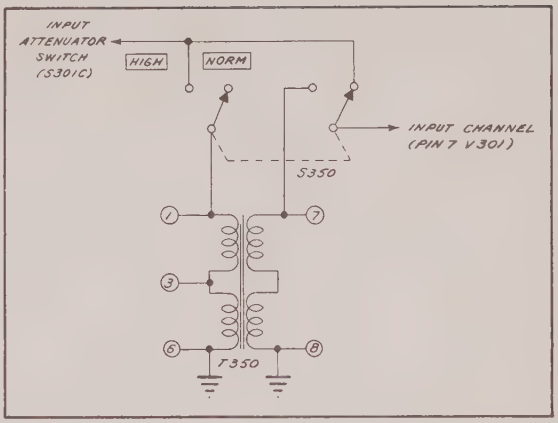


FIGURE K CIRCUIT DIAGRAM FOR MODIFICATION K

MODIFICATION L

Applicable to Preset EPUT® Meters or Preset Universal EPUT® and Timers, this modification permits remote control of the digital divider setting, as well as normal control from the front panel.

The sockets of the digital divider DCU's are wired to a female connector (J801) on the rear chassis lip. One matching plug, on a flexible lead coming out of the rear lip, is wired to the internal preset switches; another is provided for wiring to remote preset switches. Front panel control or remote control is obtained by inserting the appropriate plug into J801.

Figure L shows the internal connections to J801 and gives the recommended wiring of a manually-operated external preset switch. In this application the voltages at pins 21, 22, and 23 of J801 are not used.

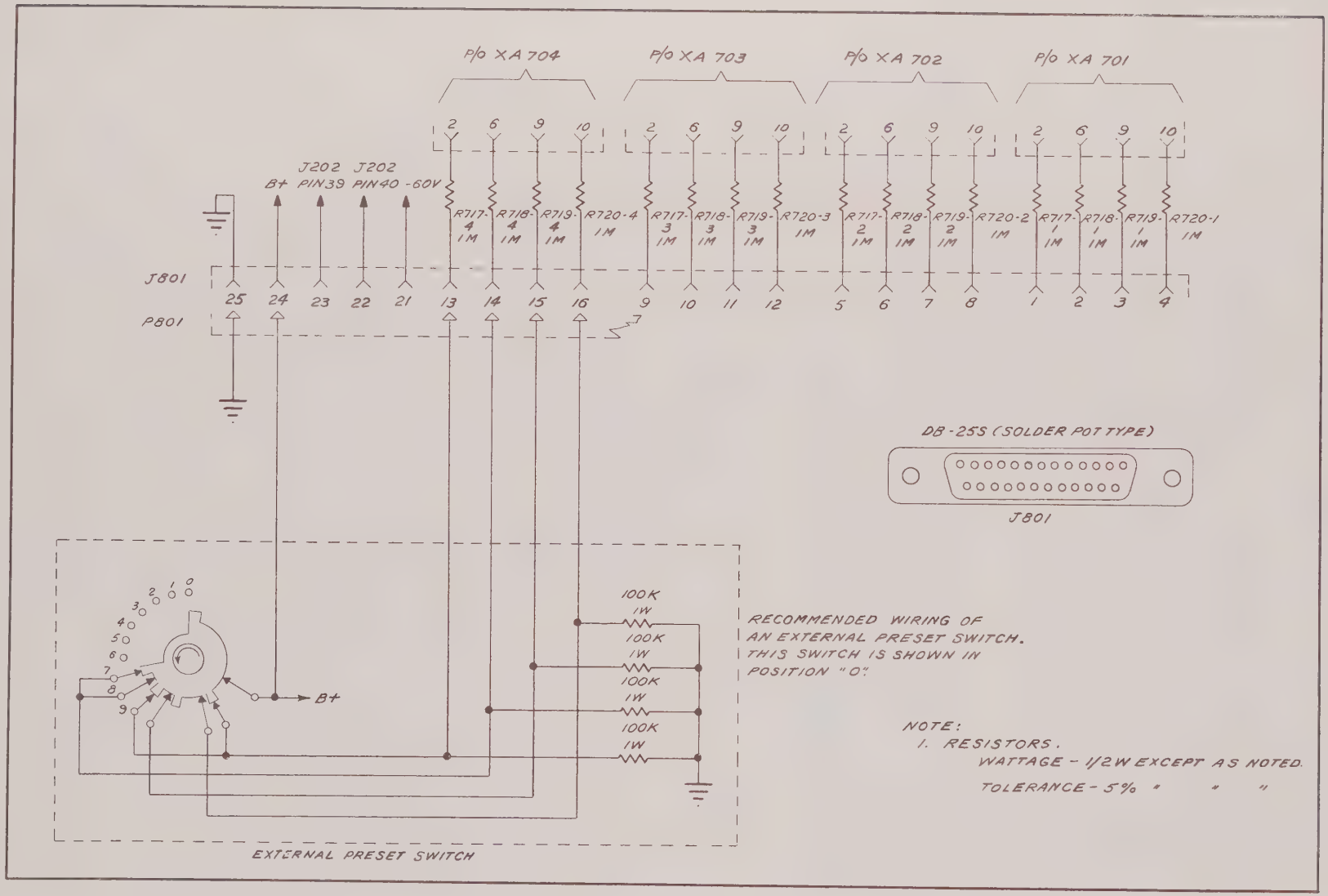


FIGURE L WIRING DIAGRAM FOR MODIFICATION L

MODIFICATION R

Instruments with this modification are intended for mounting in a standard relay rack and are supplied without a cabinet but with a top dust cover. Mounting dimensions are given in Figure R.

The air intake ports in the sides of the chassis and the exhaust opening at the back should be kept free from obstruction so that the forced-draft cooling system can work efficiently. For the same reason, the dust cover must be kept in place when the instrument is in operation, as overheating can cause serious damage to components.

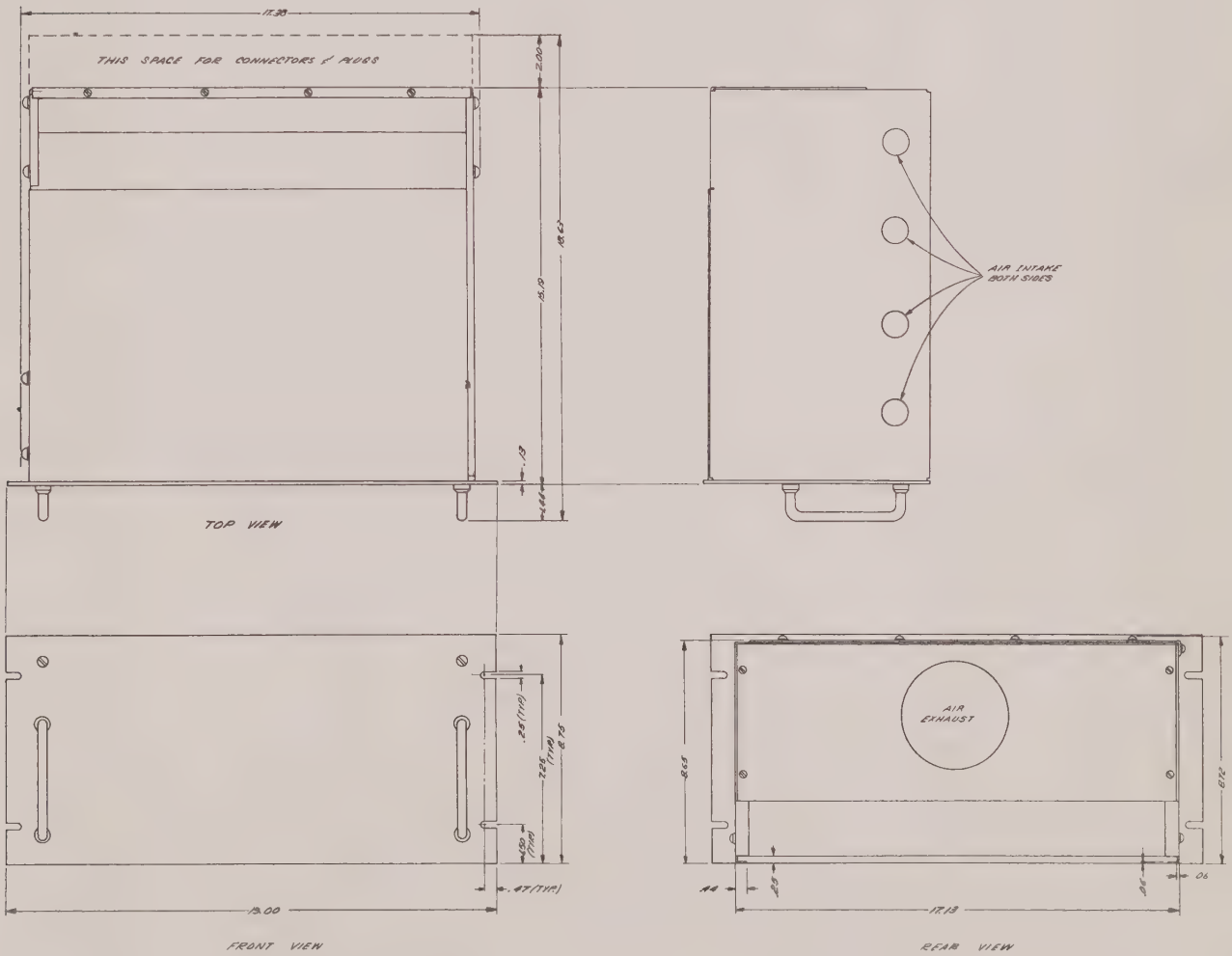


FIGURE R RACK MOUNTING DIMENSIONS FOR 7000 AND 8000 MODEL SERIES INSTRUMENTS

MODIFICATION T

In contrast to the standard Beckman / Berkeley 1-2-2-4 readout code, instruments with the T modification furnish a 1-2-4-8 readout. The modified code is supplied by special DCU's substituted for the standard units. These DCU's are designated by the letter "R" following the model number.

The only modification to the wiring of the instrument is that pin 35 of the DIGITAL RECORDER connector, J202, is grounded.

MODIFICATION U

Modification U supplies power for auxiliary equipment through an ACCESSORY socket, J101, mounted on the rear chassis lip of the instrument.

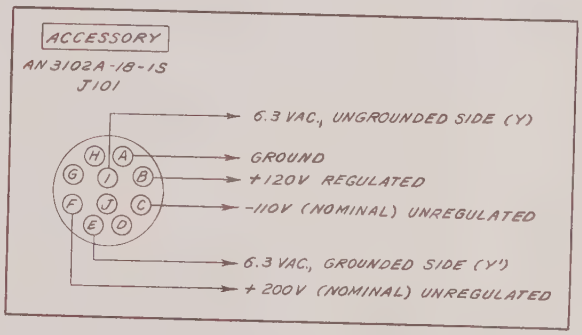


FIGURE U CONNECTIONS TO ACCESSORY SOCKET, J101, IN MODIFICATION U

MODIFICATION W

This modification adds a circuit that provides strobe pulses of variable width for external use (see Figure W).

The circuit consists of two identical one-shots (V901 and V902) driven by the "start" and "stop" pulses coming from the FUNCTION switch. One-shot V901 is triggered by "start" pulses, and V902 by "stop" pulses. When one of these negative pulses appears at the input grid (pin 7), the one-shot flips to the quasi-stable state and then back to its stable state. In so doing, it generates a negative output pulse of about 25 volts at one of the plates (pin 1). The duration of the quasi-stable state, and hence the width of the output pulse, depends on the capacitance put into the circuit by the STROBE PULSE WIDTH switch (S901).

The negative output pulses from the one-shots appear at the STROBES jacks (START, J901, and STOP, J902) on the rear panel of the instrument. Capacitors C201 and C206 are replaced by C919 and C920 respectively. The pulses can be applied to the Z axis of an oscilloscope to intensify the input waveform at the points where the input channel of a counter is being triggered.

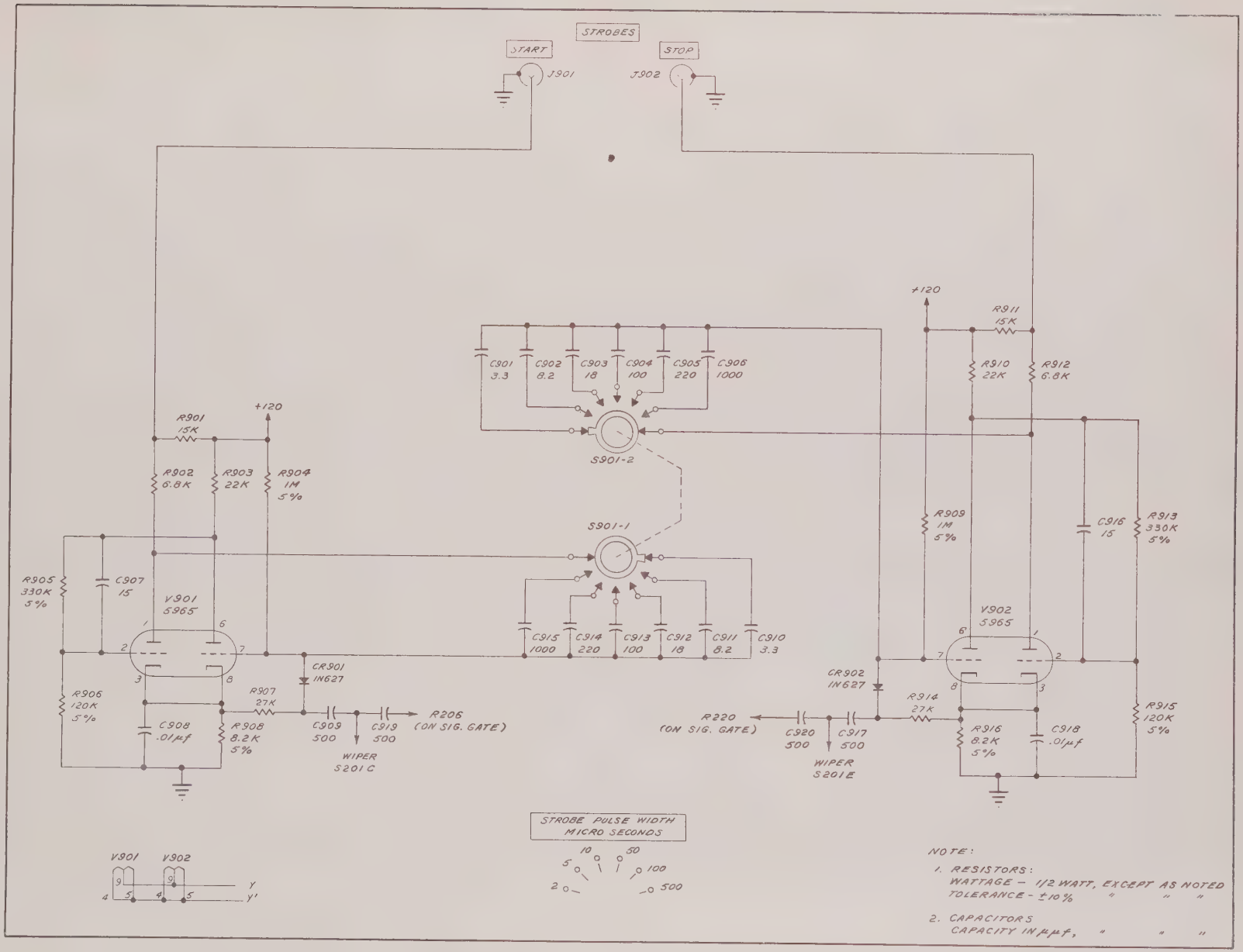


FIGURE W CIRCUIT DIAGRAM FOR MODIFICATION W

PARTS LIST, MODEL 7151 MASTER SCHEMATIC DIAGRAM

(Refer to Dwg. No. 7151 D 1.)

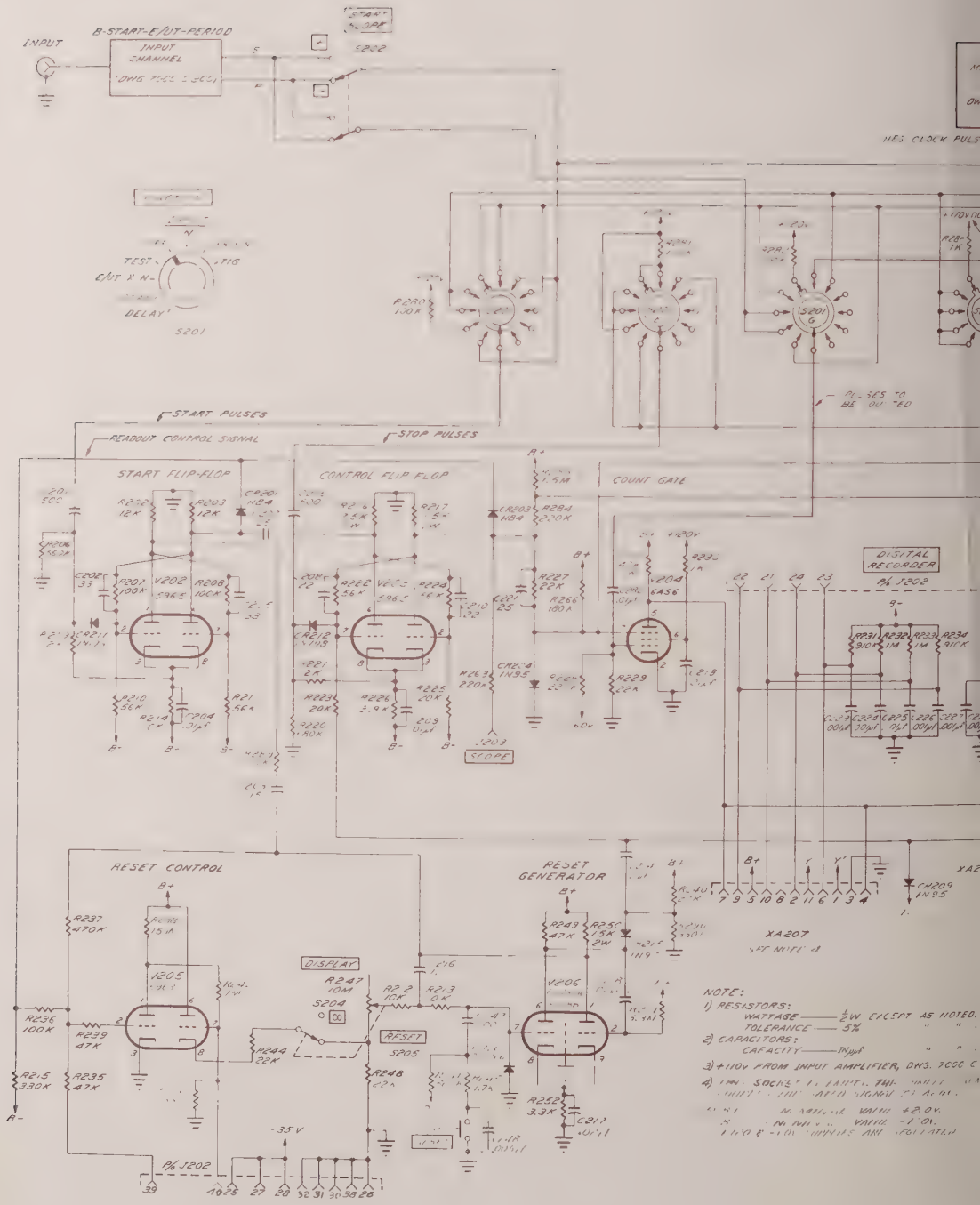
ABBREVIATIONS

BDB	Berkeley Division Beckman, Richmond, Calif.
CD	Cornell-Dubilier, S. Plainfield, N.J.
CH	Cutler-Hammer, Milwaukee, Wis.
CRL	Centralab, Milwaukee, Wis.

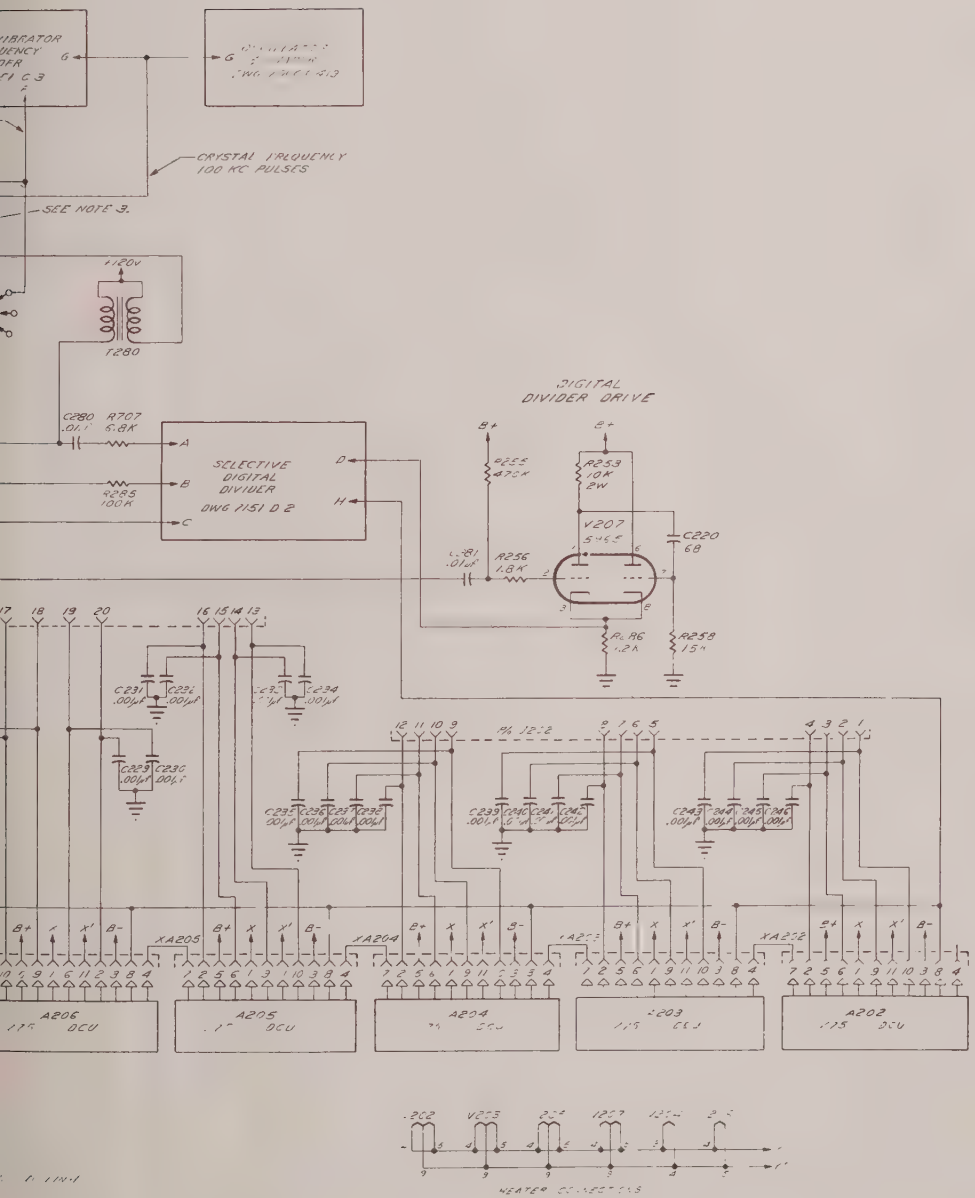
NOTE

Any resistor which does not appear in the list below is a fixed composition resistor of the value, wattage and tolerance noted on the schematic diagram. All other electrical components are listed.

Detail No.	Berkeley Stock No.	Description	Mfr. & No.
C201	2-2137	Capacitor, silvered mica, 500μμf	Sangamo RR1350
C202	2-2607	Capacitor, silvered mica, 33μμf	Sangamo RR1433
C203	2-2135	Capacitor, silvered mica, 15μμf	Sangamo RR1415
C204	2-4388	Capacitor, disc, .01μf	Sprague 29C9
C205		Same as C202	
C206		Same as C201	
C207	2-2138	Capacitor, silvered mica, 25μμf	Sangamo DR1425
C208	2-5015	Capacitor, silvered mica, 22μμf	Sangamo RR1422
C209		Same as C204	
C210		Same as C208	
C213		Same as C204	
C214	2-5691	Capacitor, paper, metalized, 0.1μf	Hopkins Eng. P14D
C216	2-6122	Capacitor, 1μf, 200V	CD PJ2W1 Tiny Chief
C217	2-6492	Capacitor, disc, .02μf	Erie 817-.02
C218	2-2230	Capacitor, disc, .01μf	Erie 811-.01
C220	2-2555	Capacitor, mica, 68μμf	Sangamo RR1468
C221		Same as C207	
C223 thru C246	2-5793	Capacitor, disc, .001μf	CRL DD102
C247		Same as C201	
C248	2-4214	Capacitor, disc, ceramic, .005μf	CRL MD501
C280		Same as C204	
C281		Same as C204	
C282		Same as C204	
CR201	8-7561	Crystal Diode, HB4	Hoffman
CR203		Same as CR201	
CR204	8-5580	Crystal Diode, 1N95	Hughes
CR206	8-7183	Crystal Diode, CD1266	Continental Devices
CR209		Same as CR204	
CR211	8-7274	Crystal Diode, 1N198	
CR212		Same as CR211	
CR215		Same as CR204	
J202	17-5620	Connector, 40 pin	Cannon DPX-40-34S
J203	17-7712	Connector, nylon, black	Whitso, JNP-11
R247	1-2956	Potentiometer, 10M, w/switch	CRL BAO26-00
S201	12-6029	Switch, rotary	BDB
S202	12-1909	Switch, DPDT	CH 8373K7
S203		Same as S202	
S204		Switch, see R247	
S205	12-0446	Switch, pushbutton, reset, DPDT	Switchcraft 203
T280	6-5821	Transformer, pulse	Pulse Eng. 5821
V202	5-3301	Tube, 5965	
V203		Same as V202	
V204	5-0500	Tube, 6AS6	
V205	5-2362	Tube, 5963	
V206	5-7562	Tube, 6DJ8/ECC88	Amperex
V207		Same as V202	
XV202	4-2973	Tube Socket, 9 pin	Elco 377BC
XV203		Same as XV202	
XV204	4-2972	Tube Socket, 7 pin	Elco 316BC
XV205		Same as XV202	
XV206		Same as XV202	
XV207		Same as XV202	
XA202 thru XA207	4-1720	Socket, 11 pin	Amphenol 77M1P11


INPUT
B-START-E/UT-PERIOD
INPUT CHANNEL
START SLOPE
S202
TEST
E/UT X N
TIG
DELAY
S201
START PULSES
READOUT CONTROL SIGNAL
STOP PULSES
START FLIP-FLOP
CONTROL FLIP-FLOP
COUNT GATE
DIGITAL RECORDER
P/O J202
RESET CONTROL
RESET GENERATOR
DISPLAY
RESET
S204
S205
P/O J202
-35V
XA207
NOTE:
1) RESISTORS:
WATTAGE ½W EXCEPT AS NOTED.
TOLERANCE 5%
2) CAPACITORS:
CAPACITY IN μμf
3) +110V FROM INPUT AMPLIFIER, DWG. 7CGC
4) TWO SOCKETS

MODEL 7151 MASTER
SCHEMATIC DIAGRAM



BECKMAN/BERKELEY DIVISION
DWG. NO. 7151 D 1

PARTS LIST MODEL 7151 MULTIVIBRATOR FREQUENCY DIVIDERS

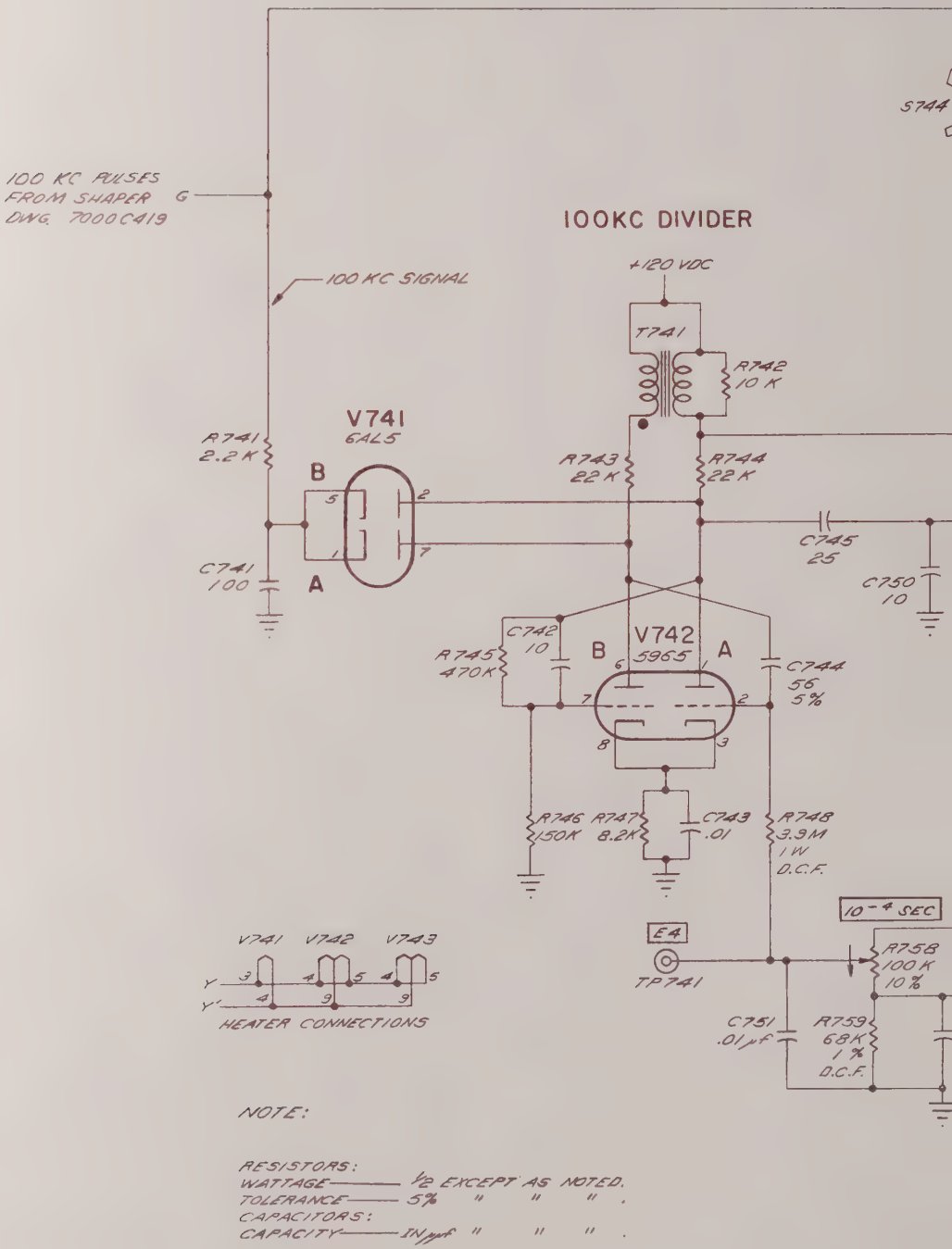
Refer to Dwg. No. 7151 C 3.

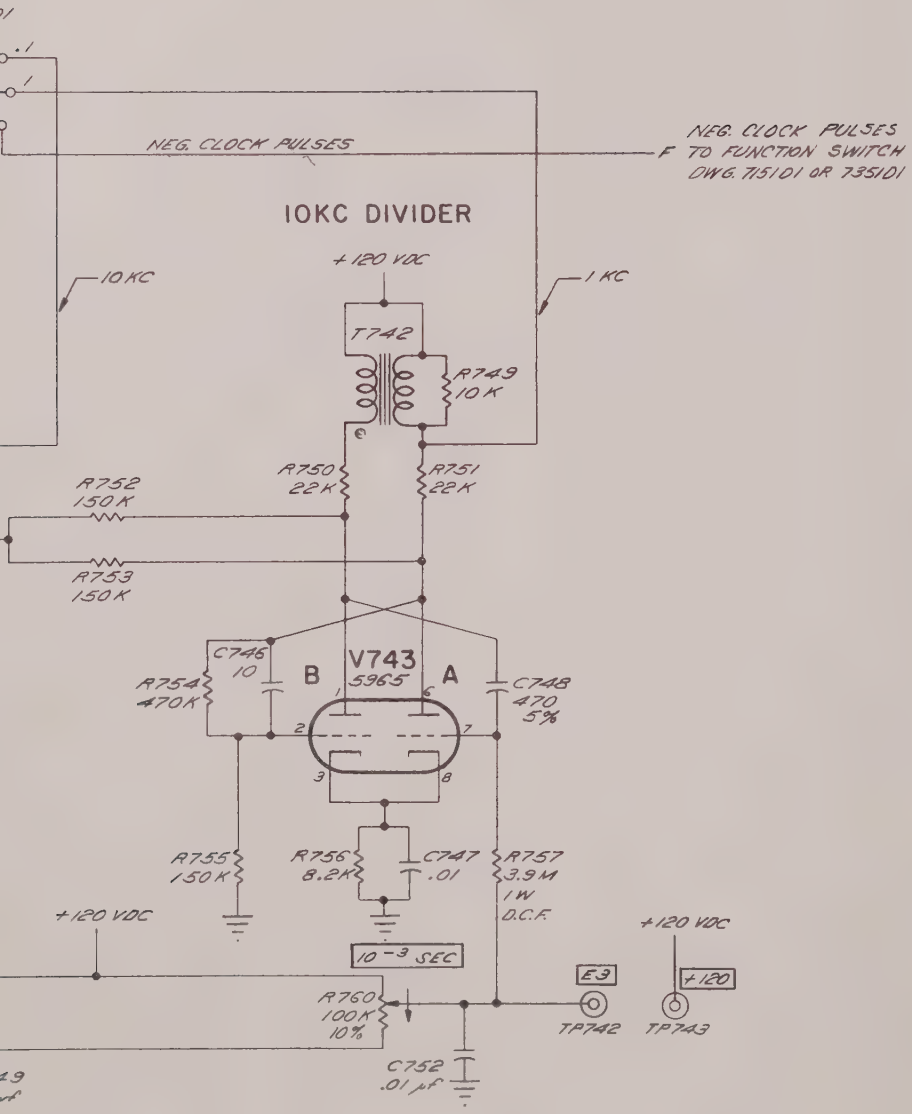
NOTE

Any resistor which does not appear in the list below is a fixed composition resistor of the value, wattage and tolerance noted on the schematic diagram. All other electrical components are listed.

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
C741	2-2136	Capacitor, silvered mica, 100 μμf	Sangamo RR1310
C742	2-2082	Capacitor, silvered mica, 10 μμf	Sangamo RR1410
C743	2-2230	Capacitor, disc, .01 μf	Erie 811-.01
C744	2-3879	Capacitor, porcelain, 56 μμf	Vitramon CY13C470JA
C745	2-2138	Capacitor, silvered mica, 25 μμf	Sangamo DR1425
C746		Same as C742	
C747		Same as C743	
C748	2-3574	Capacitor, porcelain, 470 μμf	Vitramon CY17C471JA
C749		Same as C743	
C750		Same as C742	
C751		Same as C743	
C752		Same as C743	

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
R748	1-6010	Resistor, 3.9M, 1 W, DCF	Electra DC-1
R757		Same as R748	
R759	1-7414	Resistor, 68K, 1 W, DCF	Electra DC-1
S744	12-7182	Switch, rotary	Beckman/Berkeley Div.
T741	6-6779	Transformer, pulse, 5 μs	Pulse Engineering ES6-5 1:1
T742		Same as T741	
TP741	17-7637	Tip Jack	Whitso JNP-12
TP742		Same as TP741	
TP743		Same as TP741	
V741	5-0978	Tube, 6AL5	
V742		Same as V741	
V743		Same as V741	
XV741	4-2972	Tube Socket, 7 pin, min.	Elco 316BC
XV742	4-2973	Tube Socket, 9 pin, min.	Elco 377BC
XV743		Same as XV742	


100 KC PULSES FROM SHAPER DWG. 7000C419
G
100KC DIVIDER
100 KC SIGNAL
+120 VDC
T741
R742 10 K
V741 6AL5
R741 2.2 K
B
A
R743 22 K
R744 22 K
C745 25
C750 10
C741 100
C742 10
R745 470K
V742 5965
C744 56 5%
R746 150K
R747 8.2K
C743 .01
R748 3.9M 1W O.C.F.
10⁻⁴ SEC
E4
TP741
R758 100K 10%
C751 .01μf
R759 68K 1% O.C.F.
V741 V742 V743
Y
Y'
HEATER CONNECTIONS
NOTE:
RESISTORS:
WATTAGE——— ½ EXCEPT AS NOTED.
TOLERANCE——— 5% " " " .
CAPACITORS:
CAPACITY——— IN μμf " " " .



SCHEMATIC DIAGRAM
MULTIVIBRATOR FREQUENCY DIVIDERS
MODEL 7151
DWG. NO. 7151C3

August 1959

PARTS LIST MODEL 7161 OVERALL & SWITCHING SCHEMATIC

(Refer to Dwg. No. 7161 D 1.)

ABBREVIATIONS

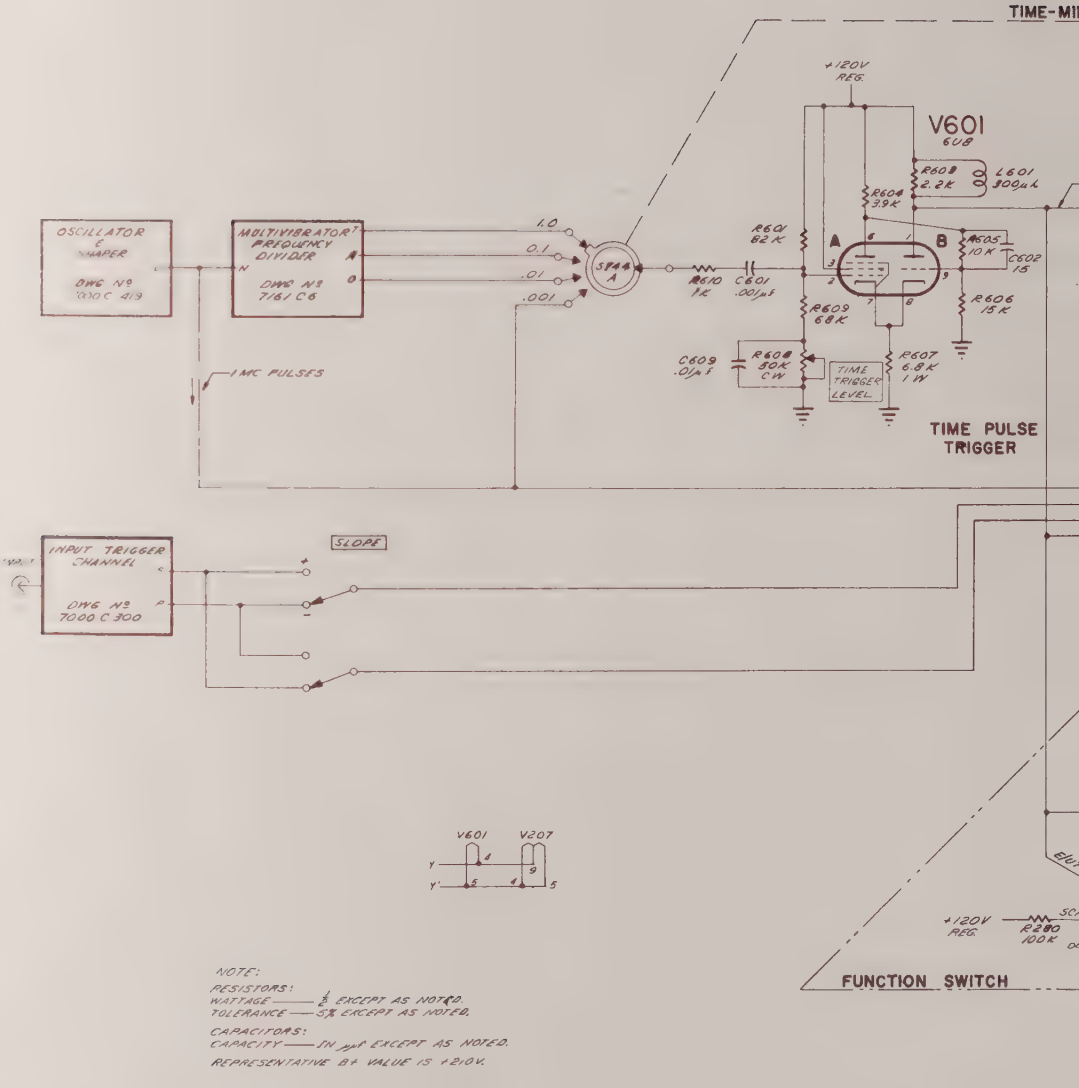
AB	Allen-Bradley, Milwaukee, Wis.
BDB	Berkeley Division Beckman, Richmond, Calif.
CRL	Centralab, Milwaukee, Wis.

NOTE

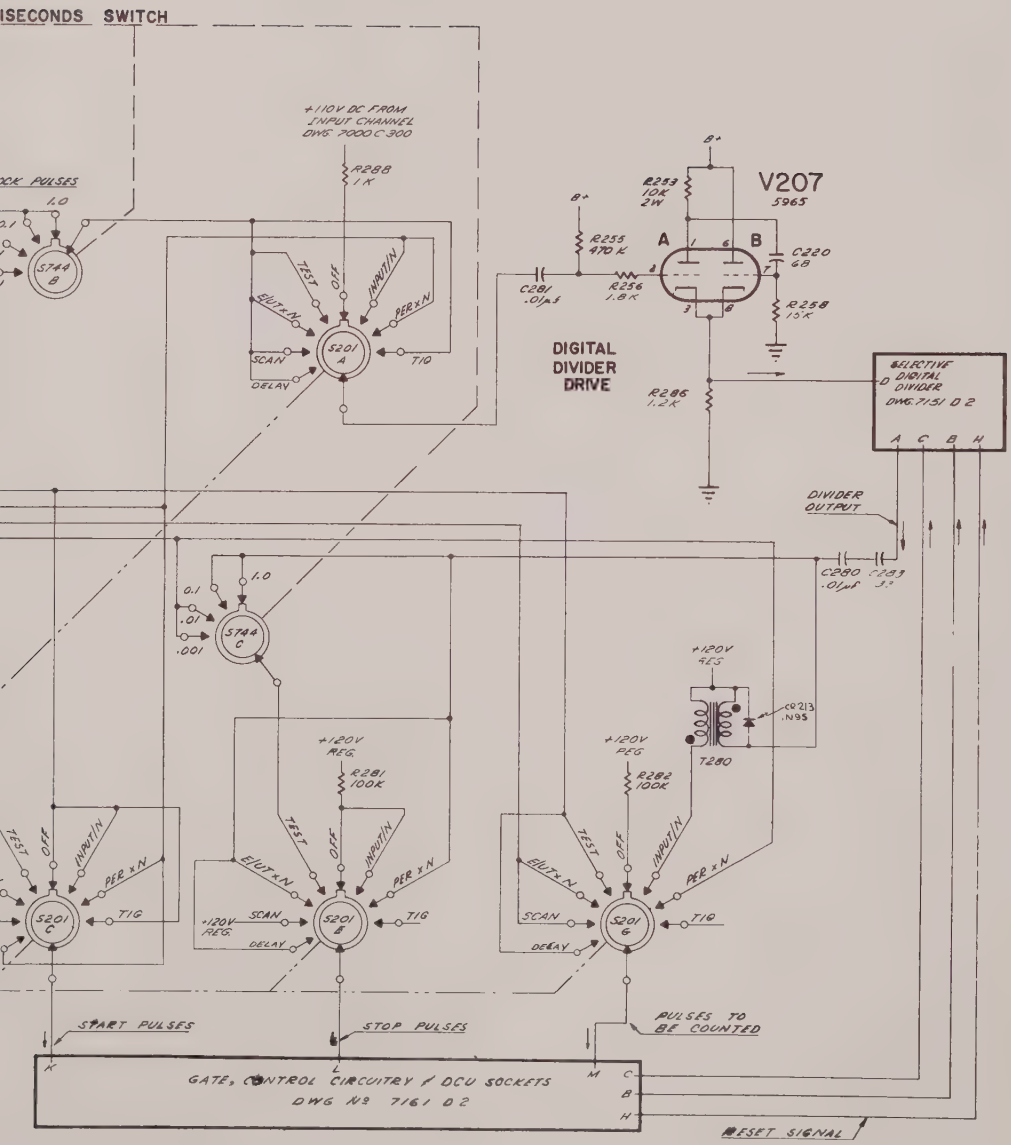
Any resistor which does not appear in the list below is a fixed composition resistor of the value, wattage and tolerance noted on the schematic diagram. All other electrical components are listed.

Detail No.	Berkeley Stock No.	Description	Mfr. & No.
C220	2-2555	Capacitor, mica, 68μμf	Sangamo RR1468
C280	2-4388	Capacitor, disc, .01μf	Sprague 59929
C281		Same as C280	
C283	2-2607	Capacitor, Mica, 33 μμf, 500V, 5%	Sangamo RR1433
C601	2-5793	Capacitor, .001μf	CRL DD102
C602	2-2135	Capacitor, 15μμf	Sangamo RR1415
C609	2-2230	Capacitor, disc, .01μf	Erie 811-.01
CR213	8-5580	Crystal Diode, 1N95	
L601	3-7317	Choke, 300μh	Wilco 1300-15

Detail No.	Berkeley Stock No.	Description	Mfr. & No.
R608	1-2318	Potentiometer, 50K, 2W, 10%	AB JU5031
S201	12-6029	Switch, rotary	BDB
S744	12-7182	Switch, rotary	BDB
T280	6-5821	Transformer, pulse	Pulse Eng. 5821
V207	5-3301	Tube, 5965	
V601	5-2526	Tube, 6U8	
XV207	4-2973	Tube Socket, 9 pin	Elco 377BC
XV601		Same as XV207	



NOTE:
RESISTORS:
WATTAGE —— ½ EXCEPT AS NOTED.
TOLERANCE —— 5% EXCEPT AS NOTED.
CAPACITORS:
CAPACITY —— IN μμf EXCEPT AS NOTED.
REPRESENTATIVE B+ VALUE IS +210V.



OVER-ALL SCHEMATIC DIAGRAM SHOWING SWITCH ACTION IN DETAIL MODEL 7161 DWG. NO. 7161D1

January 1960

PARTS LIST, GATE & CONTROL CIRCUITS, MODEL 7161 & 7361

Refer to Dwg. No. 7361 D 2

ABBREVIATIONS

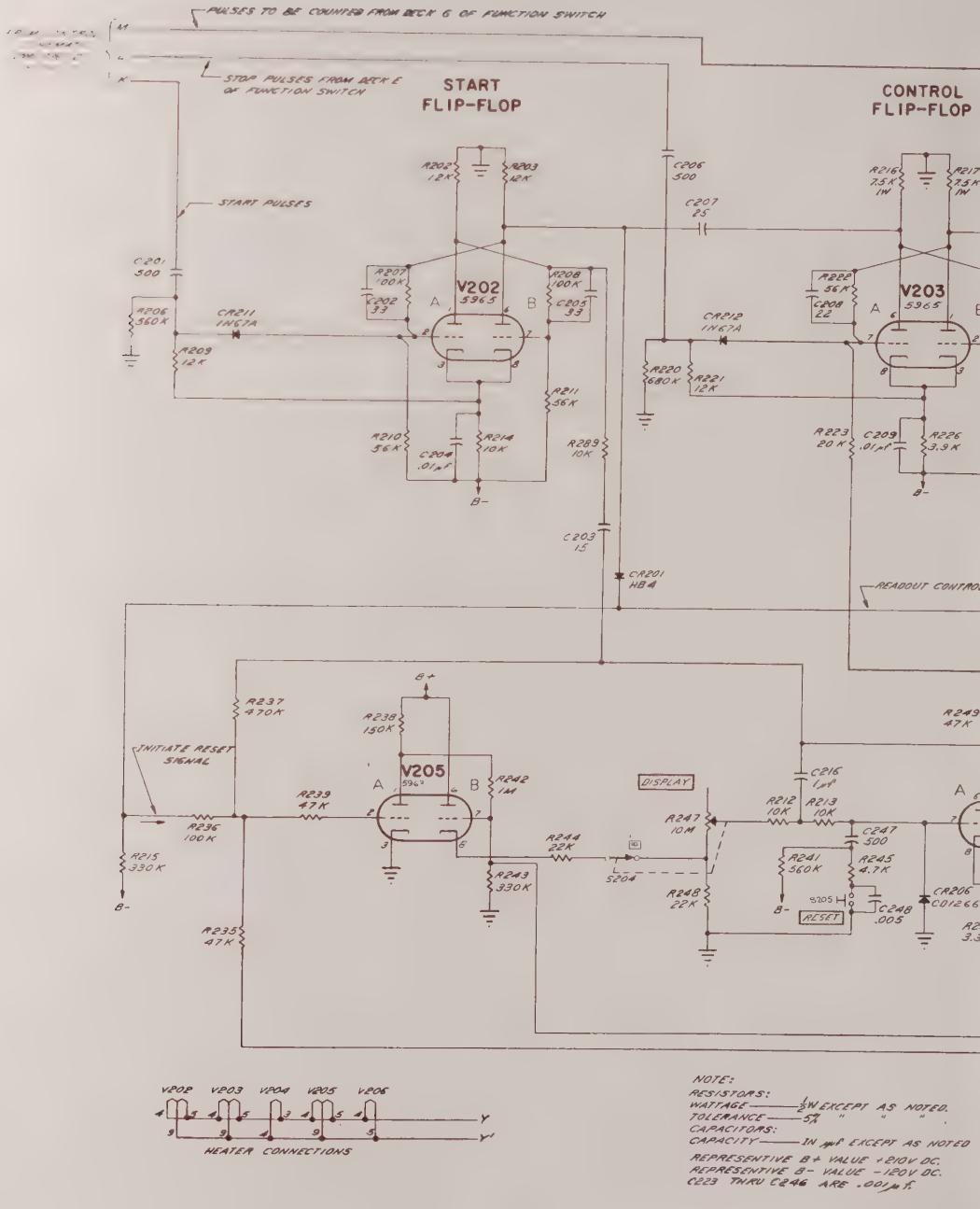
CD	Cornell-Dubilier, S. Plainfield, N.J.
CRL	Centralab, Milwaukee, Wis.

NOTE

Any resistor which does not appear in the list below is a fixed composition resistor of the value, wattage and tolerance noted on the schematic diagram. All other electrical components are listed.

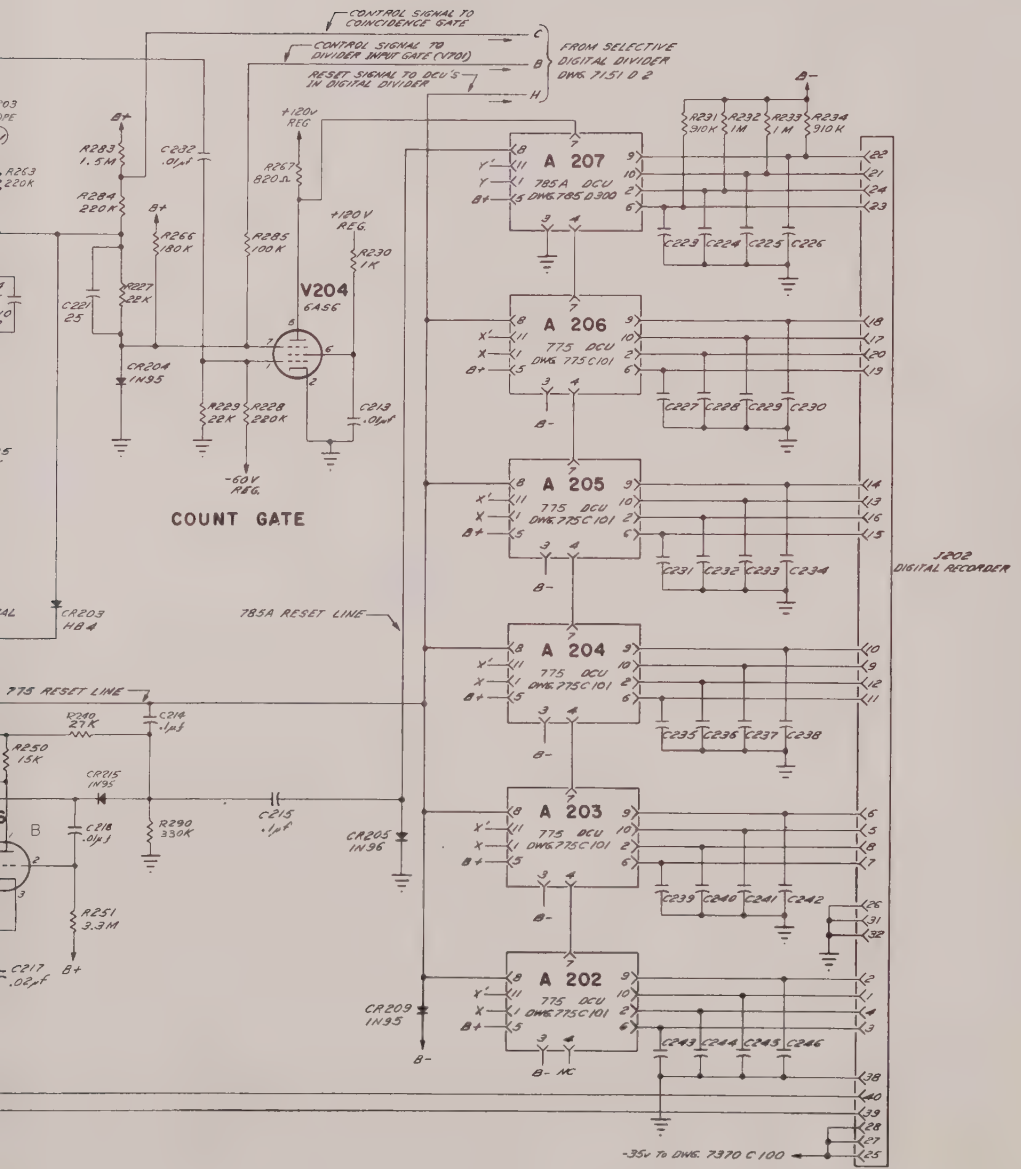
Detail No.	Berkeley Stock No.	Description	Mfr. & No.
C201	2-2137	Capacitor, silvered mica, 500 μμf	Sangamo RR1350
C202	2-2607	Capacitor, silvered mica, 33 μμf	Sangamo RR1433
C203	2-2135	Capacitor, silvered mica, 15 μμf	Sangamo RR1415
C204	2-4388	Capacitor, disc, .01 μf	Sprague 29C9
C205		Same as C202	
C206		Same as C201	
C207	2-2138	Capacitor, silvered mica, 25 μμf	Sangamo DR1425
C208	2-5015	Capacitor, silvered mica, 22 μμf	Sangamo RR1422
C209		Same as C204	
C210		Same as C208	
C213		Same as C204	
C214	2-5691	Capacitor, paper, metalized, 0.1 μf,	Hopkins Eng. P14D
C215		Same as C214	
C216	2-6122	Capacitor, paper, tubular 1 μf	CD PJ2W1 Tiny Chief
C217	2-6472	Capacitor, disc, .02 μf	Erie 817-.02
C218	2-2230	Capacitor, disc, .01 μf	Erie 811-.01
C221		Same as C202	
C223 thru C246	2-5713	Capacitor, disc, .001 μf	CRL DD102
C247		Same as C201	
C248	2-4214	Capacitor, disc, ceramic, .005 μf	CRL MD501

Detail No.	Berkeley Stock No.	Description	Mfr. & No.
C282		Same as C204	
CR201	8-7561	Diode, HB4	Hoffman
CR203		Same as CR201	
CR204	8-5580	Diode, 1N95	Hughes
CR205	8-4128	Diode, 1N96	Hughes
CR206	8-7183	Diode, CD1266	Continental Devices
CR209		Same as CR204	
CR211	8-7274	Diode, 1N198	
CR212		Same as CR211	
CR215		Same as CR204	
J202	17-5620	Connector, 40 pin, female	Cannon DPX-40-34S
J203	17-7712	Connector, nylon, black	Whitso JNP-11
R247	1-2956	Potentiometer, 10M, w/switch	CRL BAO26-00
S204		Switch, see R247	
S205	12-0446	Switch, pushbutton, DPDT	Switchcraft 203
V202	5-3301	Tube, 5965	
V203		Same as V202	
V204	5-0500	Tube, 6AS6	
V205	5-2362	Tube, 5963	
V206	5-7562	Tube, 6DJ8/ECC88	Amperex
XV202	4-2973	Tube Socket, 9 pin, min.	Elco 377BC
XV203		Same as XV202	
XV204	4-2972	Tube Socket, 7 pin, min.	Elco 316BC
XV205		Same as XV202	
XV206		Same as XV205	



NOTE:
RESISTORS:
WATTAGE — ½W EXCEPT AS NOTED.
TOLERANCE — 5% " " " .
CAPACITORS:
CAPACITY — IN μμf EXCEPT AS NOTED
REPRESENTIVE B+ VALUE +210V DC.
REPRESENTIVE B- VALUE -120V DC.
C223 THRU C246 ARE .001μf.

GATE, CONTROL & COUNTING CIRCUITS, MODELS 7161 & 7361 SCHEMATIC DIAGRAM



BECKMAN/BERKELEY DIVISION
DWG. NO. 7361 D 2

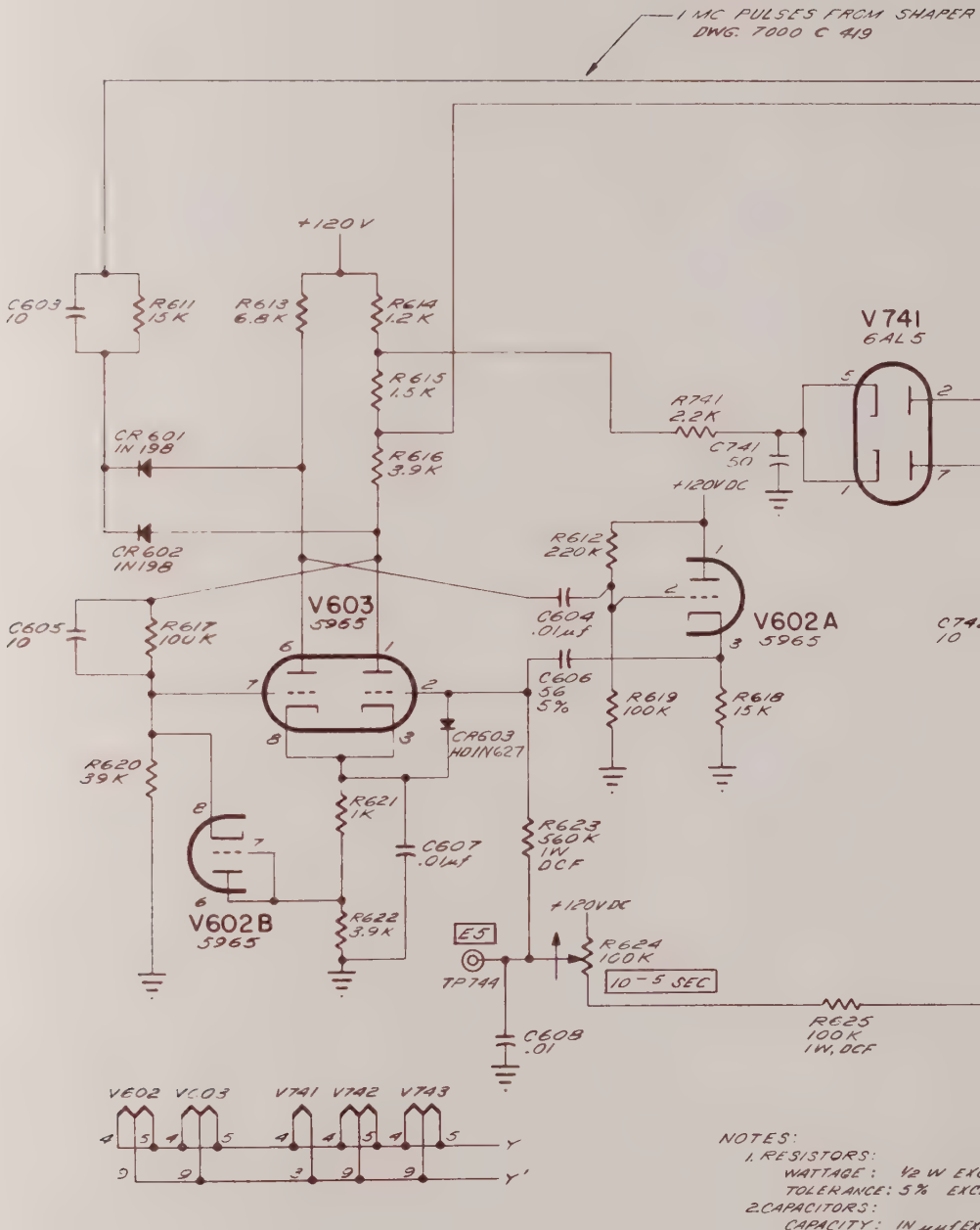
PARTS LIST, 1 MC FREQUENCY DIVIDER

Refer to Dwg. No. 7161 C 6.

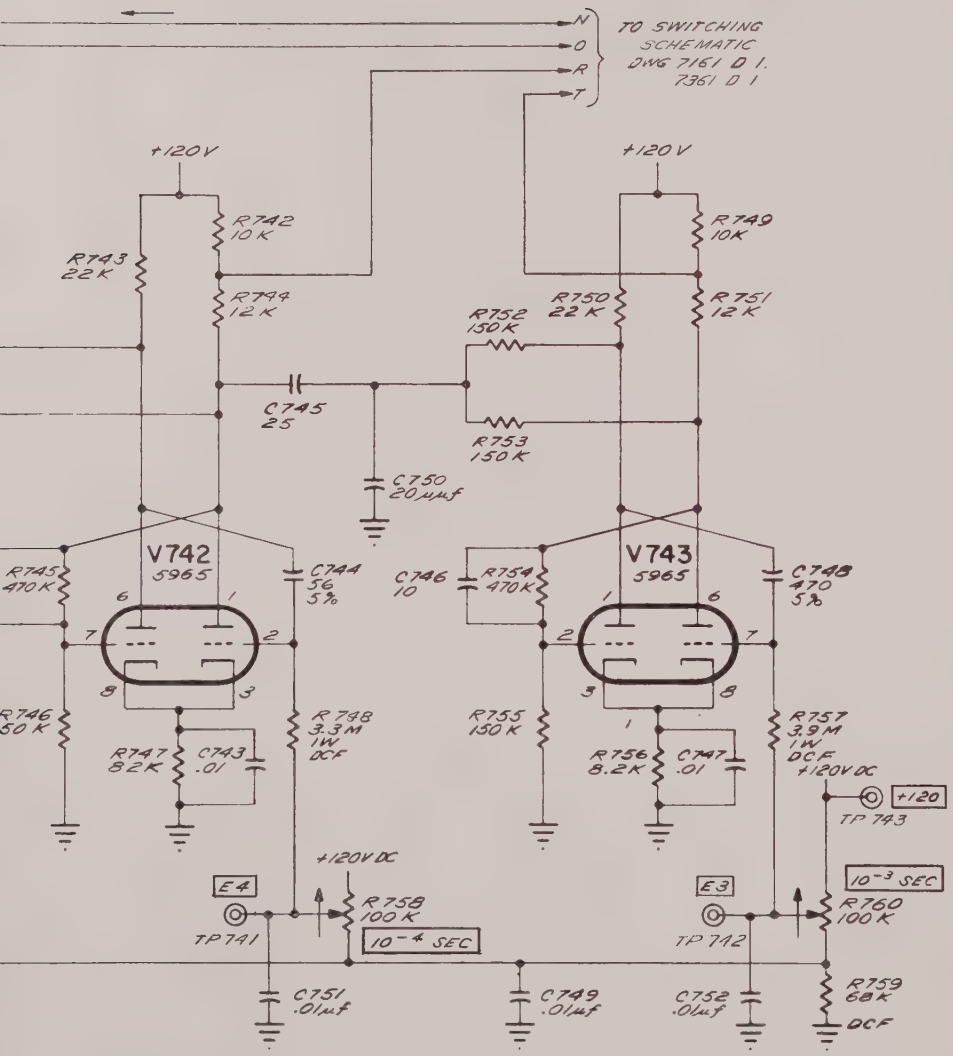
NOTE

Any resistor which does not appear in the list below is a fixed composition resistor of the value, wattage and tolerance noted on the schematic diagram. All other electrical components are listed.

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
C603	2-2082	Capacitor, silvered mica, 10 μμf	Sangamo RR1410
C604	2-2230	Capacitor, disc, .01 μf	Erie 811-.01
C605		Same as C603	
C606	2-3879	Capacitor, porcelain, 56 μμf	Vitramon CY13C470JA
C607		Same as C604	
C608		Same as C604	
C609		Same as C604	
C741	2-2141	Capacitor, mica, 50 μμf	Sangamo RR1450
C742	2-2082	Capacitor, mica, 10 μμf	Sangamo RR1410
C743		Same as C604	
C744		Same as C606	
C745	2-2138	Capacitor, silvered mica, 25 μμf	Sangamo DR1425
C746		Same as C742	
C747		Same as C604	
C748	2-3574	Capacitor, porcelain, 470 μμf	Vitramon CY17C471JA
C749		Same as C604	
C750	2-1939	Capacitor, mica, 20 μμf	Sangamo RR1420
C751		Same as C604	
C752		Same as C604	
CR601	8-7274	Diode, 1N198	
CR602		Same as CR601	
CR603	8-7453	Diode, HD1N627	Hughes Products
R623	1-6012	Resistor, DCF, 560K, 1W	Electra DC-1
R624	1-1340	Potentiometer, 100K, 2 W	Allen-Bradley JU 1041
R625	1-7413	Resistor, DCF, 100K, 1 W	Electra DC-1
R748	1-7412	Resistor, DCF, 3.3M, 1 W	Electra DC-1
R757	1-6010	Resistor, DCF, 3.9M, 1 W	Electra DC-1
R758		Same as R624	
R759	1-7414	Potentiometer, 68K, 1W, 5%	Electra DC-1
R760		Same as R624	
TP741 thru TP744	17-7637	Connector, tip jack	Whitso JNP-12
V602	5-3301	Tube, 5965	
V603		Same as V602	
V741	5-0978	Tube, 6AL5	
V742		Same as V602	
V743		Same as V602	
XV602	4-2973	Tube Socket, 9 pin, min.	Elco 377BC
XV603		Same as XV602	
XV741	4-2972	Tube Socket, 7 pin, min.	Elco 316BC
XV742		Same as XV602	
XV743		Same as XV602	


1 MC PULSES FROM SHAPER
DWG. 7000 C 419
+120 V
C603 10
R611 15 K
R613 6.8 K
R614 1.2 K
R615 1.5 K
R616 3.9 K
CR 601 IN 198
CR 602 IN198
V741 6AL5
R741 2.2K
C741 50
+120VDC
R612 220K
V603 5965
V602A 5965
C605 10
R617 100K
C604 .01μf
C606 56 5%
R619 100K
R618 15K
CR603 HD1N627
R620 39K
R621 1K
C607 .01μf
R623 360K 1W DCF
V602B 5965
R622 3.9K
+120VDC
E5
TP744
R624 100K
10⁻⁵ SEC
R625 100K 1W, DCF
C608 .01
V602 V603 V741 V742 V743
Y
Y'
NOTES:
1. RESISTORS:
WATTAGE : ½ W EX
TOLERANCE: 5% EX
2. CAPACITORS:
CAPACITY: IN μμf EX
C748
C744
C606
TIMING CAPACITOR
TYPE 70

1 MC FREQUENCY DIVIDER
SCHEMATIC DIAGRAM



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E VITRAMON

BECKMAN/BERKELEY DIVISION
DWG. NO. 7161 C 6

PARTS LIST, INPUT CHANNEL

Refer to Dwg. No. 7000C300

ABBREVIATIONS

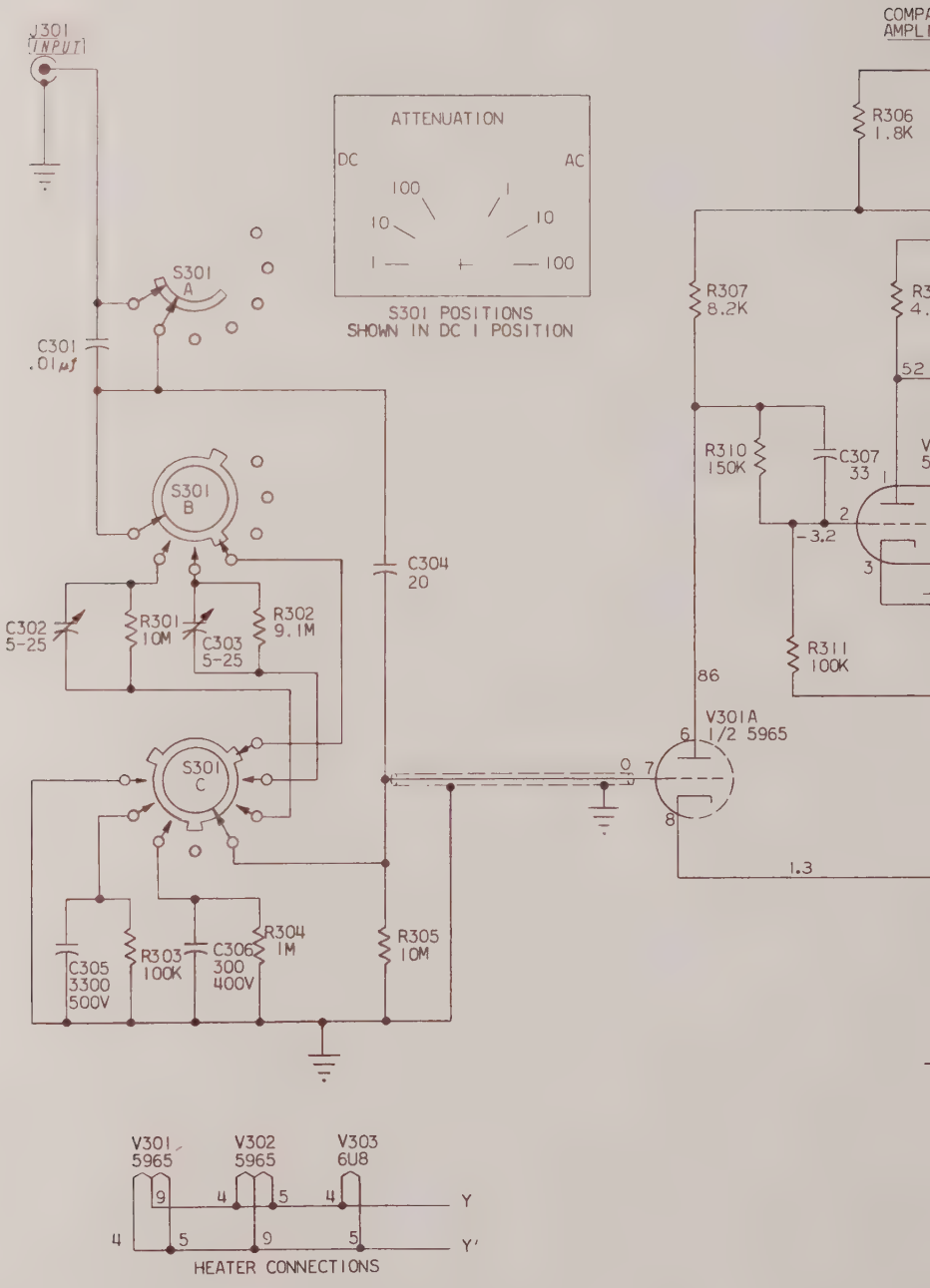
AB	Allen-Bradley Company, Milwaukee, Wisconsin
BDB	Berkeley Division Beckman, Richmond, California
GE	General Electric, Schenectady, New York
IPC	Industrial Products Co., Danbury, Connecticut
RCA	Radio Corporation of America, Harrison, New Jersey

NOTE

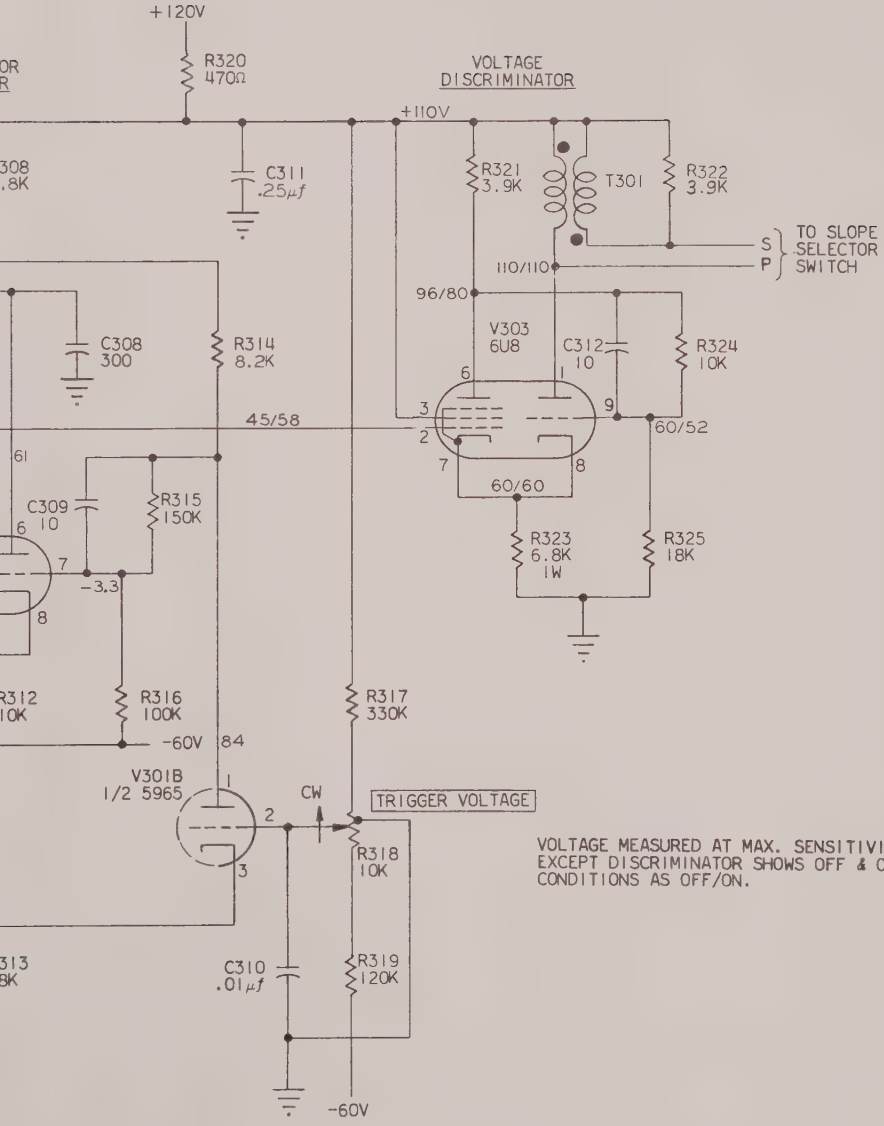
The following parts list includes all electrical components exceptfixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
C301	2-2230	Cap., .01 μfd, ceramic disc	Erie 811
C302 & C303	2-2326	Capacitor, 5-25 μμfd, Variable	Erie 557-F
C304	2-1939	Capacitor, 20 μμfd, Mica	Sangamo RR 1420
C305	2-6474	Capacitor, 3300 μμfd, Mica	Sangamo CR 1233
C306	2-2608	Capacitor, 300 μμfd, Mica	Sangamo RR 1330
C307	2-2607	Cap., 33 μμfd, Mica	Sangamo RR 1433
C308	2-2608	Cap., 300 μμfd, Mica	Sangamo RR 1330
C309	2-2082	Cap., 10 μμfd, Mica	Sangamo RR 1410
C310	2-2230	Same as C301	Erie 811
C311	2-5747	Cap., .25 Mfd, 200 V Metalized	Hopkins Eng.
C312		Same as C309	

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
J301 & J302	17-3179	Connector, Low Voltage	IPC MS 595
R318	1-5573	Potentiometer, 10K, 2W, 20%, 40% tap.	AB JU1032-SD3048
S301	12-5698	Switch, 2 Sec., 7 Pos.	
T301	6-5821	Transformer, Pulse 300 μ H	BDB
V301 & V302	5-3301	Tube, 5965	RCA
V303	5-2526	Tube, 6U8	GE
XV301, XV302 & XV303	4-2973	Socket, 9 Pin W/O Shield W/ Lugs	Elco 377BC


J301
INPUT
ATTENUATION
DC
AC
100
1
10
10
1
100
S301 POSITIONS
SHOWN IN DC 1 POSITION
S301
A
S301
B
S301
C
C301
.01 μf
C302
5-25
R301
10M
C303
5-25
R302
9.1M
C304
20
C305
3300
500V
R303
100K
C306
300
400V
R304
1M
R305
10M
R306
1.8K
R307
8.2K
R310
150K
C307
33
R311
100K
V301A
6 1/2 5965
-3.2
86
1.3
V301
5965
V302
5965
V303
6U8
Y
Y'
HEATER CONNECTIONS

INPUT CHANNEL
SCHEMATIC DIAGRAM



VOLTAGE MEASURED AT MAX. SENSITIVITY, EXCEPT DISCRIMINATOR SHOWS OFF & ON CONDITIONS AS OFF/ON.

NOTE:

RESISTORS:

WATTAGE	1/2W UNLESS NOTED OTHERWISE.
TOLERANCE	5% UNLESS NOTED OTHERWISE.

CAPACITORS:

CAPACITY	IN μμf UNLESS NOTED OTHERWISE.
VOLTAGE RATING	

BECKMAN/BERKELEY DIVISION
DWG. NO. 7000 C 300

PARTS LIST, OSCILLATOR & SHAPER

Refer to Dwg. No. 7000 C 419.

ABBREVIATIONS

BDB	Berkeley Division Beckman, Richmond, Calif.
CRL	Centralab, Milwaukee, Wis.
JFD	JFD Electronics, Brooklyn, N. Y.
AB	Allen-Bradley Company, Milwaukee, Wisconsin

NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Berkeley Stock No.	Description	Mfr. & No.
C401	2-2230	Capacitor, disc, ceramic, .01 μf	Erie 811-.01
*C402	2-2137	Capacitor, silvered mica, 500 μμf	Sangamo RR1350
**C402	2-3068	Capacitor, silvered mica, 180 μμf	Sangamo RR1318
*C403	2-7535	Capacitor, silvered mica, 1200 μμf	Sangamo KR1212
**C403	2-2172	Capacitor, silvered mica, 400 μμf	Sangamo RR1340
*C404	2-3157	Capacitor, silvered mica, 39 μμf	Sangamo RR1439
**C404	2-6065	Capacitor, ceramic, 56μμf, 600V, 5%	Erie NPO
C405		Same as C401	
C406		Same as C401	
C407	2-2135	Capacitor, silvered mica, 15 μμf	Sangamo RR1415
C408		Same as C401	
C409	2-5491	Capacitor, silvered mica, 150 μμf	Sangamo RR1315
*C410	2-5617	Capacitor, variable, 100 μμf	Hammarlund MAPC-101
**C410	2-5706	Capacitor, variable, 2-18 μμf	JFD VC-4
C411	2-4268	Capacitor, electrolytic, 5 μf, 8 v.	Barco PS8-5
C412	2-5793	Capacitor, disc, ceramic, .001 μf	CRL DD102
C413		Same as C412	
**C414	2-2136	Capacitor, silvered mica, 100 μμf	Sangamo DR1310
C415		Same as C401	
C416		Same as C401	
C417	2-5747	Capacitor, paper, metalized, .25 μf	Hopkins MPA .25-200
CR401	8-7274	Diode, 1N198	
J401	17-4985	Test Jack, UG 1094/U	
**L401	3-6328	Inductor, 240 μh	Wilco 3240-15
*L402	3-6397	Inductor, 400 μh	Wilco 1400-15
**L402		Same as L401	
S401	12-1643	Switch, toggle, SPST	BDB
V401	5-2526	Tube, 6U8	Sylvania
V402		Same as V401	
XV401	4-2973	Tube Socket, 9 pin, min.	Elco 377BC
XV402		Same as XV401	
XY401	4-3213	Crystal Socket, octal mica filled	Cinch 16203
*Y401	13-6325	Crystal, 100 kc, w/oven	BDB
**Y401	13-5696	Crystal, 1 mc, w/oven	BDB

ADDITIONS

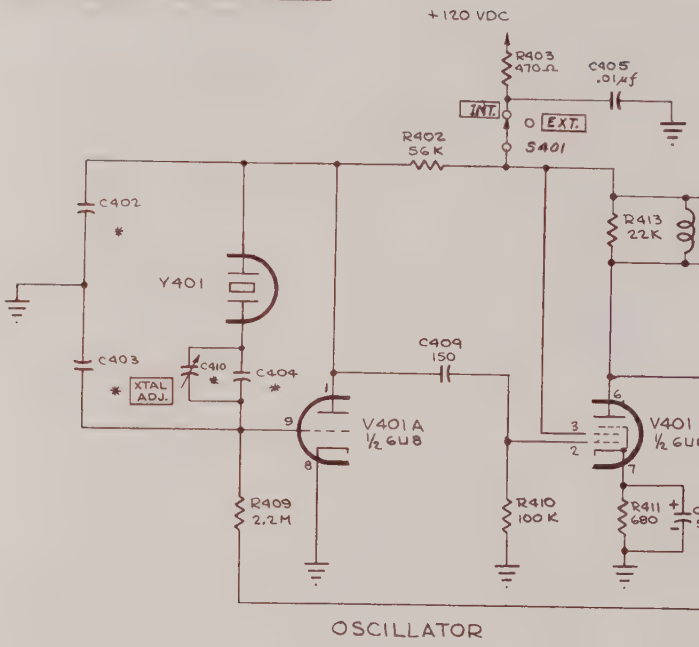
I401	21-1677	Lamp	General Electric 47
R414	1-2318	Potentiometer, 50K, 2W, 20%	AB JU5032-SD3048
XI401	4-3324	Socket, lamp	Drake 101

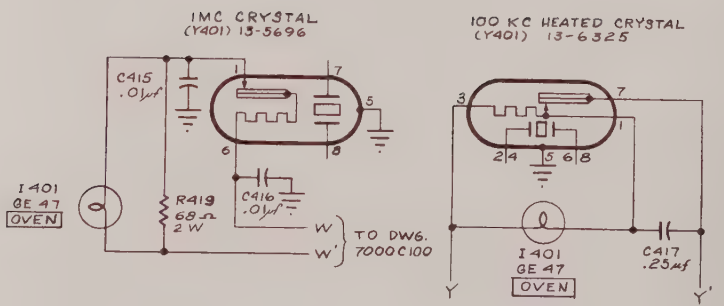
*For instruments using 100 kc crystal.

**For instruments using 1 mc crystal.

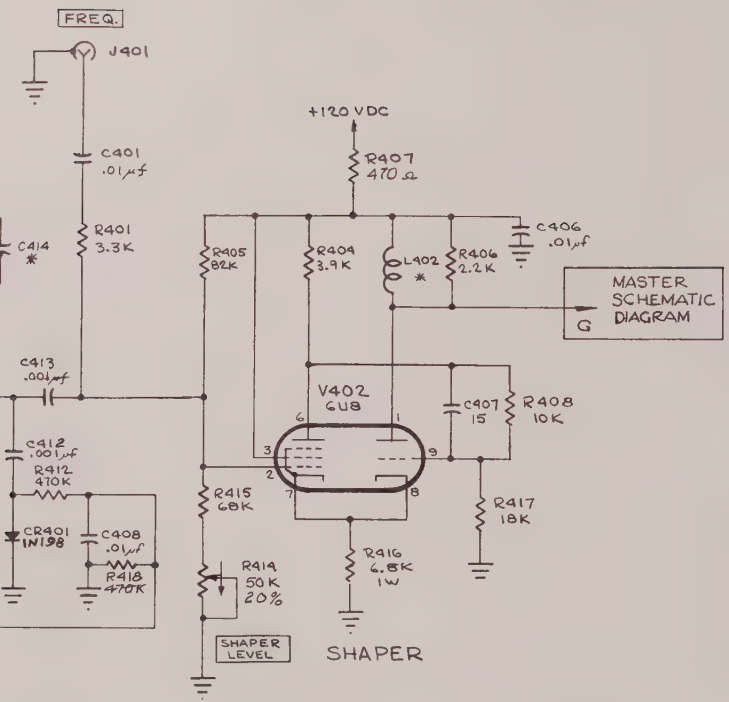
* COMPONENT VALUES ARE AS LISTED BELOW

COMP.	WITH 1 MC XTAL	WITH 100 KC XTAL
C402	180 μμf	500 μμf
C403	400 μμf	1200 μμf
C409	56 μμf (NOM.)	39 μμf (NOM.)
C410	2-18 μμf	100 μμf VAR.
C414	100 μμf	NOT USED
L401	240 μh	NOT USED
L402	240 μh	400 μh





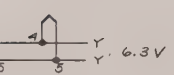
OSCILLATOR AND SHAPER SCHEMATIC DIAGRAM



NOTE:

1. RESISTORS:
   WATTAGE - ½W UNLESS OTHERWISE NOTED
   TOLERANCE - 10% " " "
2. CAPACITORS:
   CAPACITY - IN μμf UNLESS OTHERWISE NOTED

C CRYSTAL UNHEATED
401) 13-6326



March 1961

BECKMAN/ BERKELEY DIVISION
DWG. NO. 7000 C 419

PARTS LIST, PRESET DIGITAL DIVIDER

(Refer to Dwg. No. 7151 D 2.)

ABBREVIATIONS

BDB	Berkeley Division Beckman, Richmond, Calif.
VDC	Volts direct current

NOTE

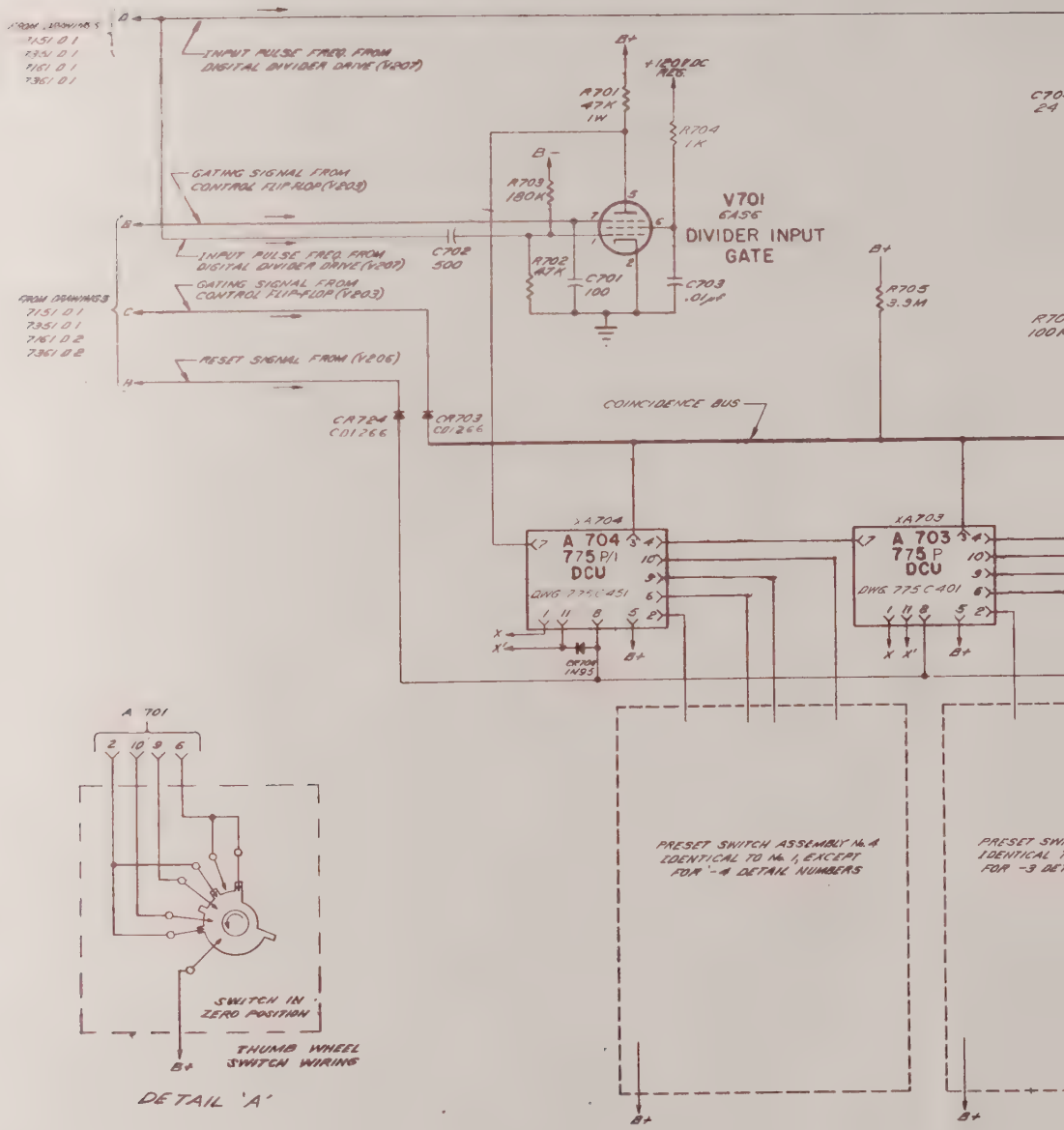
Any resistor which does not appear in the list below is a fixed composition resistor of the value, wattage and tolerance noted on the schematic diagram. All other electrical components are listed.

tail o.	Berkeley Stock No.	Description	Mfr. & No.
01	2-2136	Capacitor, silvered mica, 100μμf, 500VDC	Sangamo RR1310
02	2-2137	Capacitor, silvered mica, 500μμf, 300VDC	Sangamo RR1350
03	2-2230	Capacitor, disc, .01μf	Erie 811-.01
04	2-2554	Capacitor, silvered mica, 24μμf, 500VDC	Sangamo RR 1424
05		Same as C703	
06		Same as C703	
07		Same as C703	
08		Same as C703	
701	8-7274	Diode, 1N198	Transitron

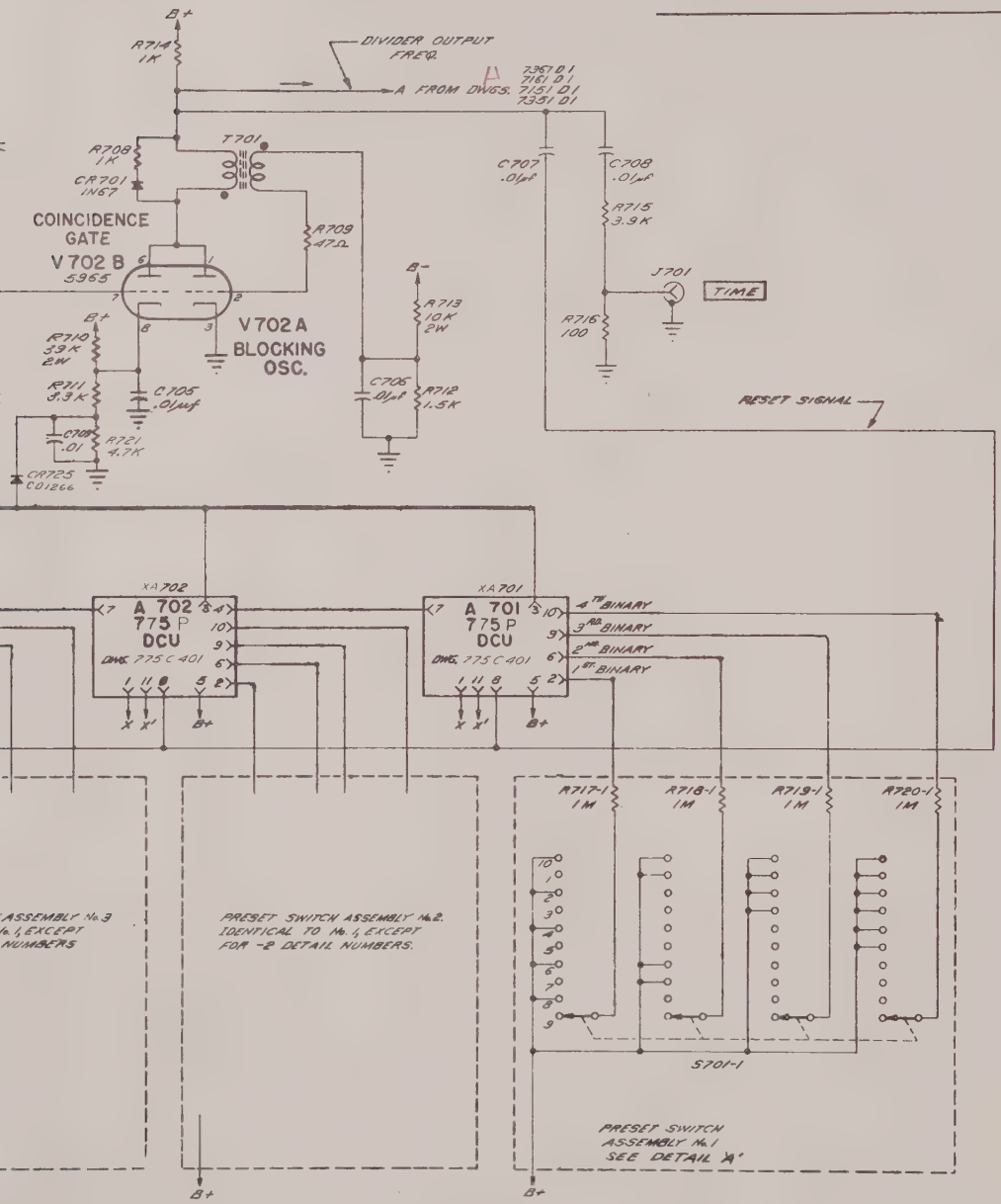
Detail No.	Berkeley Stock No.	Description	Mfr. & No.
CR702	8-7183	Diode, CD1266	Continental Devices
CR703		Same as CR702	
CR704	8-5580	Diode, 1N95	
CR724		Same as CR702	
J701	17-4985	Connector, UG1094/U	
S701	12-7572	Switch, rotary	BDB
T701	6-7715	Transformer, pulse	BDB
V701	5-0500	Tube, 6AS6	
V702	5-3301	Tube, 5965	
XV701	4-2972	Tube Socket, 7 pin, min.	Elco 316BC
XV702	4-2973	Tube Socket, 9 pin, min.	Elco 377BC

ADDITIONS

709	2-4388	Capacitor, disc, .01μf	Sprague 59929
R725	8-7183	Diode, CD1266	Continental Devices


FROM DRAWINGS 7151 D1 7351 D1 7161 D1 7361 D1
INPUT PULSE FREQ. FROM DIGITAL DIVIDER DRIVE (V807)
GATING SIGNAL FROM CONTROL FLIP-FLOP (V803)
INPUT PULSE FREQ. FROM DIGITAL DIVIDER DRIVE (V207)
GATING SIGNAL FROM CONTROL FLIP-FLOP (V803)
FROM DRAWINGS 7151 D1 7351 D1 7161 D2 7361 D2
RESET SIGNAL FROM (V206)
A701 47K 1W
+100 V DC REG.
R704 1K
A703 180K
V701 6A56 DIVIDER INPUT GATE
C702 500
A702 47K
C701 100
C703 .01 μf
R705 3.9M
COINCIDENCE BUS
CR704 CD1266
CR703 CD1266
XA704
A 704 775 P/1 DCU
DWG 775 C451
XA703
A 703 775 P DCU
DWG 775 C401
CR704 IN93
A 701
SWITCH IN ZERO POSITION
THUMB WHEEL SWITCH WIRING
DETAIL 'A'
PRESET SWITCH ASSEMBLY No. 4 IDENTICAL TO No. 1, EXCEPT FOR '-4 DETAIL NUMBERS
V701
V702
HEATER CONNECTIONS
NOTE:
RESISTORS:
WATTAGE — 1/2 W, EXC
TOLERANCE — 5 %,
CAPACITORS:
CAPACITY — IN μμf;
NOMINAL — B+ VALUE +
NOMINAL — B- VALUE -
X = FILAMENT
X' = FILAMENT B- CONNECTIO

PRESET DIGITAL DIVIDER
SCHEMATIC DIAGRAM



AS NOTED.
" " .
" " .
DC.
DC.

March 1961

BECKMAN/BERKELEY DIVISION
DWG. NO. 7151 D 2

PARTS LIST, POWER SUPPLY

Refer to Dwg. No. 7370 C 100.

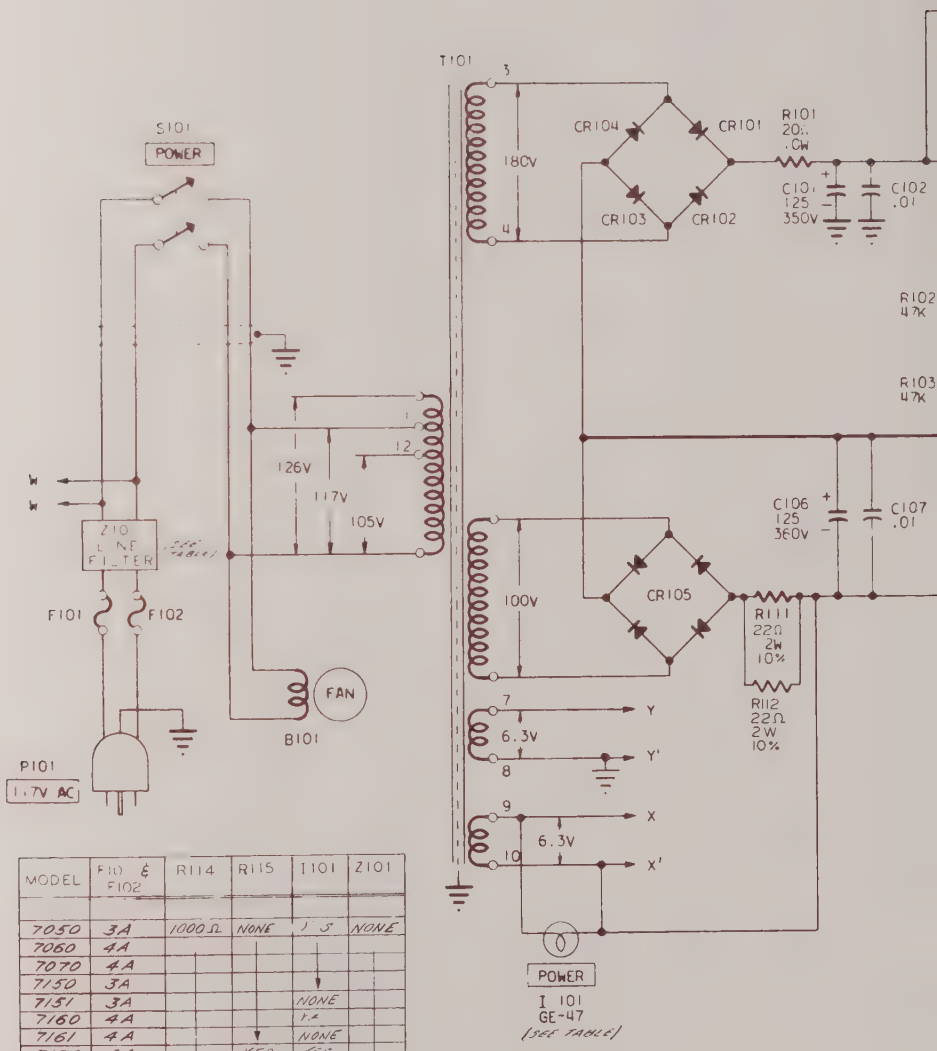
ABBREVIATIONS

AB	Allen-Bradley Co., Milwaukee, Wis.
BDB	Berkeley Division Beckman, Richmond, Calif.
CH	Cutler-Hammer Co., Milwaukee, Wis.
DCF	Deposited carbon film
GE	General Electric, Schenectady, N.Y.
Gen. Ind.	General Industries, Elyria, Ohio
VDC	Volts direct current
WW	Wirewound

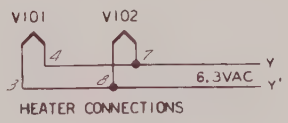
NOTE

Any resistor which does not appear in the list below is a fixed composition resistor of the value, wattage and tolerance noted on the schematic diagram. All other electrical components are listed.

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
B101	9-3390	Fan Motor	Gen. Ind. A5CW
C101	2-4254	Capacitor, 125μf, 350 v.	Mallory FP140
C102	2-2230	Capacitor, disc, .01μf	Erie Type 811-.01
C103		Same as C102	
C104	2-3982	Capacitor, electrolytic, 8μf, 250 v.	Sangamo MT 2508
C105		Same as C102	
C106		Same as C101	
C107		Same as C102	
C108	2-5937	Capacitor, 0.1μf, ±20%, 200VDC	Sangamo 330201
CR101	8-4425	Rectifier, silicon	Sarkes Tarzian M500
CR102		Same as CR101	
CR103		Same as CR101	
CR104		Same as CR101	
CR105	8-5633	Rectifier, 110 v rms, 110VDC, 130ma	GE 6R21PB3AT1
CR106	8-7228	Diode	BDB
F101	7-5824	Fuse, SloBlo, 4 amp., 125 v.	Littelfuse 313004 3 AG
F102		Same as F101	
I101	21-1677	Lamp	GE 47
R101	1-2927	Resistor, 20Ω, 10W	Tru-Ohm FRL-10
R106	1-6257	Resistor, DCF, 1 meg., 1W	Arnhold Ceramics Stemag Type A2
R107	1-2905	Potentiometer, Linear Carbon, 500K, 2W	AB JU 5041 SD 3048
R113	1-6258	Resistor, DCF, 500K, 1W	Arnhold Ceramics Stemag Type A2
R114 (All Models except 7270 & 7370)	1-0998	Resistor, WW, 1000Ω, 10W, 10%	Tru-Ohm FRL-10
R114 (Models 7270 & 7370)	1-7267	Resistor, WW, 600Ω, 10W	Tru-Ohm FRL-10
R115	1-1067	Resistor, WW, 2K, 10W	Tru-Ohm FRL-10
S101	12-1642	Switch, toggle, DPST	CH 8370 K8
T101	6-7265	Transformer, power	BDB
V101	5-0550	Tube, 6AU6	
V102	5-2625	Tube, 6080	
XCR101	24-4459	Spring Clip	Littelfuse 099062
XCR102		Same as XCR101	
XCR103		Same as XCR101	
XCR104		Same as XCR101	
XF101	4-3154	Fuse Post	Bussman HKP
XF102		Same as XF101	
XI101	4-1678	Lamp Socket Assy., green jewel	Dialco 81410-132
XV101	4-2972	Tube Socket, 7 pin	Elco 316BC
XV102	4-2377	Tube Socket, octal	Cinch 9950

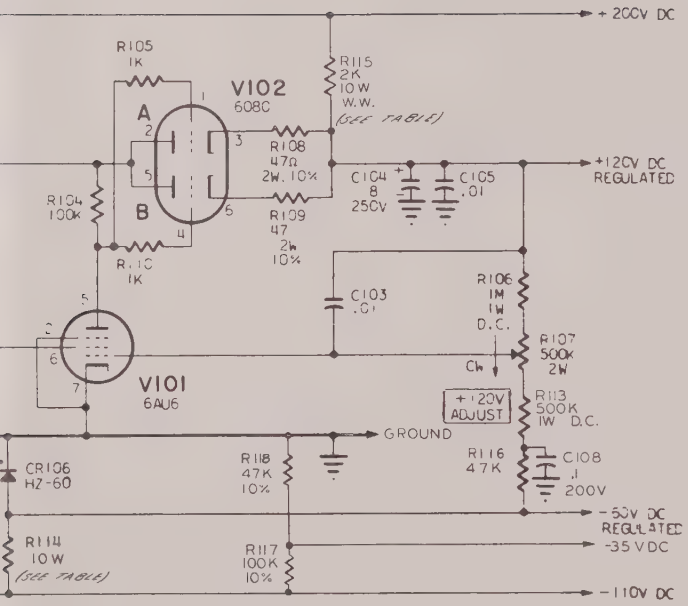


MODEL	F101 & F102	R114	R115	T101	Z101
7050	3A	1000Ω	NONE		NONE
7060	4A				
7070	4A				
7150	3A				
7151	3A			NONE	
7160	4A				
7161	4A			NONE	
7170	4A		YES		
7250	3A		NONE		
7260	4A				
7270	4A	600Ω	YES		
7350	3A	1000Ω	NONE		
7351	3A			NONE	
7360	4A			YES	
7361	4A			NONE	
7370	4A	600Ω	YES	YES	
5571	4A	1000Ω	NONE		
[illegible]	4A				
[illegible]	4A				
[illegible]	4A			NONE	NONE



HEATER CONNECTIONS

POWER SUPPLY
SCHEMATIC DIAGRAM



NOTE:

RESISTORS:

WATTAGE ——— $\frac{1}{2}$ W UNLESS NOTED OTHERWISE.

TOLERANCE ——— 5% UNLESS NOTED OTHERWISE.

CAPACITORS:

CAPACITY ——— IN μf UNLESS NOTED OTHERWISE.

POWER SUPPLY VOLTAGES ARE NOMINAL ONLY.
SEE INSTRUCTION MANUAL FOR PERMISSABLE VARIATION DC LEVEL.
ALL VOLTAGES ARE AC UNLESS OTHERWISE NOTED.

INSTRUCTION MANUAL

Models 775, 775AJ & 775K
DECIMAL COUNTING UNITS

Beckman

Berkeley Division
2900 Wright Avenue, Richmond 5, California
a division of Beckman Instruments, Inc.

1960

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in posession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

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BECKMAN INSTRUMENTS, INC.

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INTRODUCTION

These decimal counting units are direct-reading, plug-in electronic counters. The number of input pulses received is indicated by the illumination of one of ten neon lamps placed behind a numbered acetate panel. Each unit counts from zero to nine, the tenth pulse resetting the counter to zero and simultaneously generating an output signal. Any number of these units can be connected in cascade (the output of one unit driving the next) forming a counter whose total count capacity depends only on the number of DCU's. Thus, five units will count to 99, 999 resetting to "00, 000" on the 100, 000th pulse.

Models 775 and 775K generate a binary coded decimal readout. This code is in the form of high or low voltages at each of four pins on the DCU plug.

SPECIFICATIONS

Count Indication

Direct reading, decimal presentation

Power Requirements

Heaters: 6.3 v. at 1.2 amps
Plates: 300 v. at 13 ma

Input Requirements

Negative pulses (see "OPERATION")

Output Characteristics

Designed to drive a Model 775 DCU or any modification except a 775LJ (i.e., 775AJ, 775K, etc.).

Resolution of Paired Pulses

5 microseconds

Reset

Will reset to either zero or nine depending on polarity of reset pulse applied.

Maximum Counting Rate

120, 000 counts per second

Construction

Plug-in unit, 11-pin socket

OPERATION

Power Requirements. The heaters require 6.3 volts a-c at 1.2 amperes. The plate circuits may be operated on from 200 to 400 volts, although the design center is 300 volts at 13 ma. Plate voltage may be applied in the form of B + and B - voltages. The d-c level of all output voltages will depend upon the level of the plate supply voltages.

Input Requirements. A negative pulse at least two microseconds wide is required to drive the unit. The optimum pulse amplitude depends on the rise time. With a rise time of 0.5 microseconds (measured between ten and ninety percent values) the pulse amplitude should be between 75 and 135 volts. With a two-microsecond rise time, the amplitude should be between 120 and 165 volts. When operating the plate circuits on 300 volts, optimum performance is obtained with a rise time of one microsecond or less and a pulse amplitude of 100 volts. If the unit is powered by unregulated d-c supplies, the input pulse amplitude should vary in phase with the supply voltage. The input load presented when an input pulse occurs is 15K ohms in series with 100 picofarads ($\mu\mu$f).

Output Characteristics. The output is the rectangular waveform shown in Figure 3. As every tenth input pulse triggers the unit from count display "9" to count display "0", a negative transient occurs at pin 4 of the DCU plug. With a plate supply of 300 volts, the potential at pin 4 drops from +135 to +55 volts with respect to B-. This transient can be used to drive succeeding decimal counting units or other circuitry. The load impedance connected

between the output terminal and ground must not be less than 300K or 6K in series with 100 picofarads.

Method of Resetting after a Counting Period. A DCU can be reset to a registered count of either zero or nine by the application of a voltage pulse of the proper polarity to the proper pin of the DCU plug. See the table below.

	RESET TO ZERO		RESET TO NINE	
	Pulse Polarity	Applied at Pin No.	Pulse Polarity	Applied at Pin No.
775	Neg.	8	Pos.	8
775AJ	Neg.	8	Pos.	8
	Pos.	3	Neg.	3
775K	Neg.	8	Pos.	8

The reset pin (or pins in the base of Model 775AJ) should be maintained at the B- supply voltage except when a reset pulse occurs. A 50-volt pulse at least 3μseconds wide is adequate. A 100-volt pulse need be only 1.5μseconds wide. There is no maximum pulse width; however the DCU will not begin counting again until the reset pin returns to the B- supply voltage.

Simply disconnecting a reset pin from B- with a switch or relay will have the same effect as applying a positive pulse.

Binary Code Readout. Models 775 and 775K generate a modified binary code representing the decimal digit registered. The code appears in the form of a voltage (high or low) at one plate of each of four double-triode binaries. In the table below, "0" represents a plate voltage of approximately +55 volts with respect to B-; "1" represents a plate voltage of about +135 volts with respect to B-. (These are the voltage levels which appear when using a 300-volt plate supply.) Each of the four plates is coupled to a pin of the DCU plug through a 1.2 megohm resistor except in the case of pin 4 on the 775K DCU. This pin is connected directly to a plate of the fourth binary. To obtain a readout voltage at this pin, it is necessary to add a 1.2M resistor externally.

DECIMAL DIGIT REGISTERED	FOUR - LINE BINARY CODE			
	1st Binary Stage	2nd Binary	3rd Binary	4th Binary
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	1	1	0
5	1	1	1	0
6	0	0	1	1
7	1	0	1	1
8	0	1	1	1
9	1	1	1	1

Extinguishing the Indicating Lamps During the Counting Period. On Models 775 and 775K, it is possible to prevent the neon bulbs from lighting by placing approximately -100 volts with respect to B- on pin 10 of the DCU plug. Ordinarily, the user will wish to extinguish the bulb while the DCU is actively counting, and to allow them to light, indicating the registered count at the end of a counting period.

CIRCUIT DESCRIPTION

The Binaries. The decimal counting units contain four "flip-flop" circuits. These circuits are slightly modified versions of the Eccles-Jordan trigger circuit. They are referred to here as binaries.

Figure 1 is a schematic diagram of a typical binary. It consists of two triode voltage amplifiers with the plate of each direct-coupled to the grid of the other. With no input this circuit assumes one of two stable states: V1 conducting steadily and V2 cut

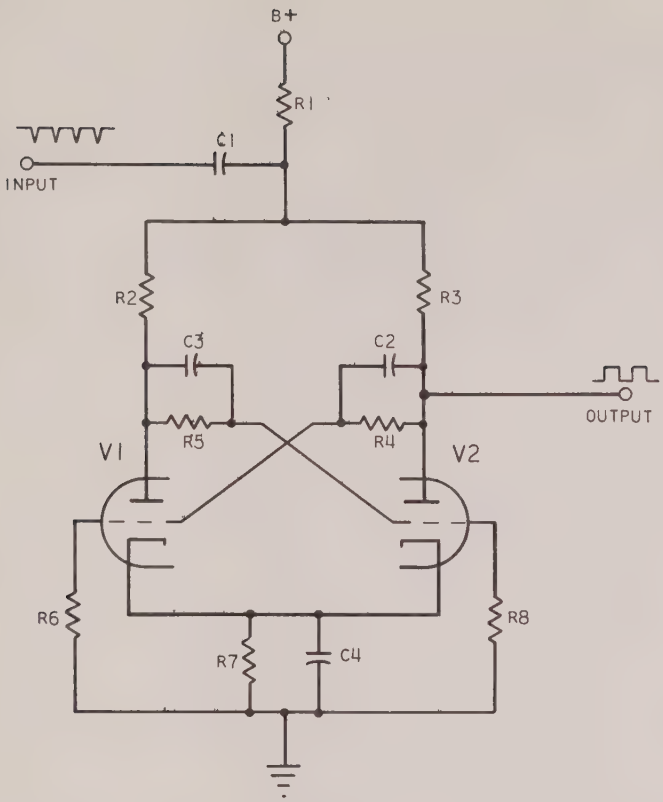


FIGURE 1. A TYPICAL BINARY.

off, or V2 conducting and V1 cut off. Suppose V1 is not conducting. Then, its plate is near the B- voltage. A portion of this voltage, applied to the grid of V2 through the voltage dividing network R5 and R8, raises this grid above cut-off and permits V2 to conduct. While V2 is conducting, the low positive potential at its plate, coupled to the grid of V1 through the dividing network R4 and R6, holds this grid several volts below cut-off. Since small changes in the potential at the grid of V1 will not raise it above cut-off, this state is stable and will persist until disturbed by an appreciable input signal. Notice that, since the circuit is symmetrical, the opposite state is equally stable.

The circuit is triggered from one state to another by negative pulses applied at the input. For example, assume that V2 is conducting and V1 is cut off. If a negative pulse is applied to the input, there is a drop in the plate voltage of V1. This drop in voltage is transmitted through a crossover network (R5, R8, C3 and the grid-to-ground capacitance of V2) and applied to the grid of V2. The plate voltage of V2 then starts to rise, carrying with it the grid of V1. If the input pulse is of sufficient amplitude, V1 begins to conduct. The moment V1 conducts, the drop in voltage at its plate, coupled to the grid of V1, reinforces the negative transient there. This regenerative action proceeds rapidly until V2 is cut off and V1 is conducting at a steady rate. The next adequate input transient causes a reverse action and returns the binary to its original state. Thus, the binary completes a cycle for every two input transients applied, making it a scale-of-two. The output is the drop in voltage at one of the plates as that triode begins to conduct. This output, consisting of one negative transient for every two input transients, is suitable for driving another binary. By connecting binaries in cascade (output of one to input of the next) a counter having a scale of any power of two can be built.

The Scale of Ten. In the Model 775 four binaries are connected in cascade forming a scale-of-16 which is permuted to a scale-of-10 by two positive feedback paths. (See Figures 2 and 3). For the first three negative input pulses, the unit operates like a simple binary counter. At the fourth input pulse, the third binary is triggered for the first time, sending a pulse through the first feedback path which triggers the second binary. Since it requires two input pulses to trigger the second binary, this is equivalent to adding two input pulses; therefore, the state of the unit now

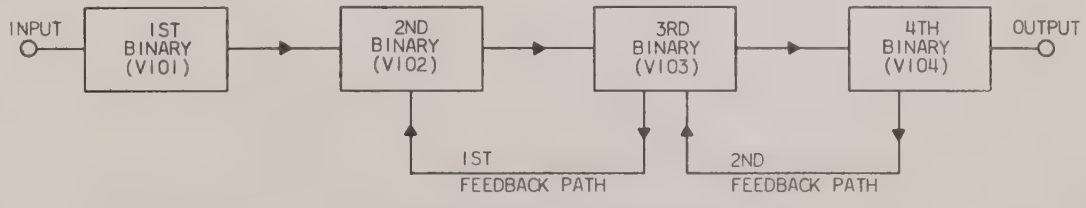


FIGURE 2. BLOCK DIAGRAM.

corresponds to a binary count of six. The sixth input pulse (equivalent to the eight in a simple binary chain) triggers the fourth binary which sends a pulse through the second feedback path, triggering the third binary. This is equivalent to adding four more input pulses so the state of the unit now corresponds to a binary count of 12. For the next four input pulses (7 thru 10) the unit operates again as a simple binary chain, producing an output pulse at the tenth input pulse. Adding the equivalent of six input pulses internally has changed the binary chain from a scale-of-16 to a scale-of-10.

When the third binary is triggered by a feedback pulse, it tends to retrigger the second binary in the same way that it did at the time of input pulse four. This tendency is offset by a simultaneous opposing signal from the fourth binary.

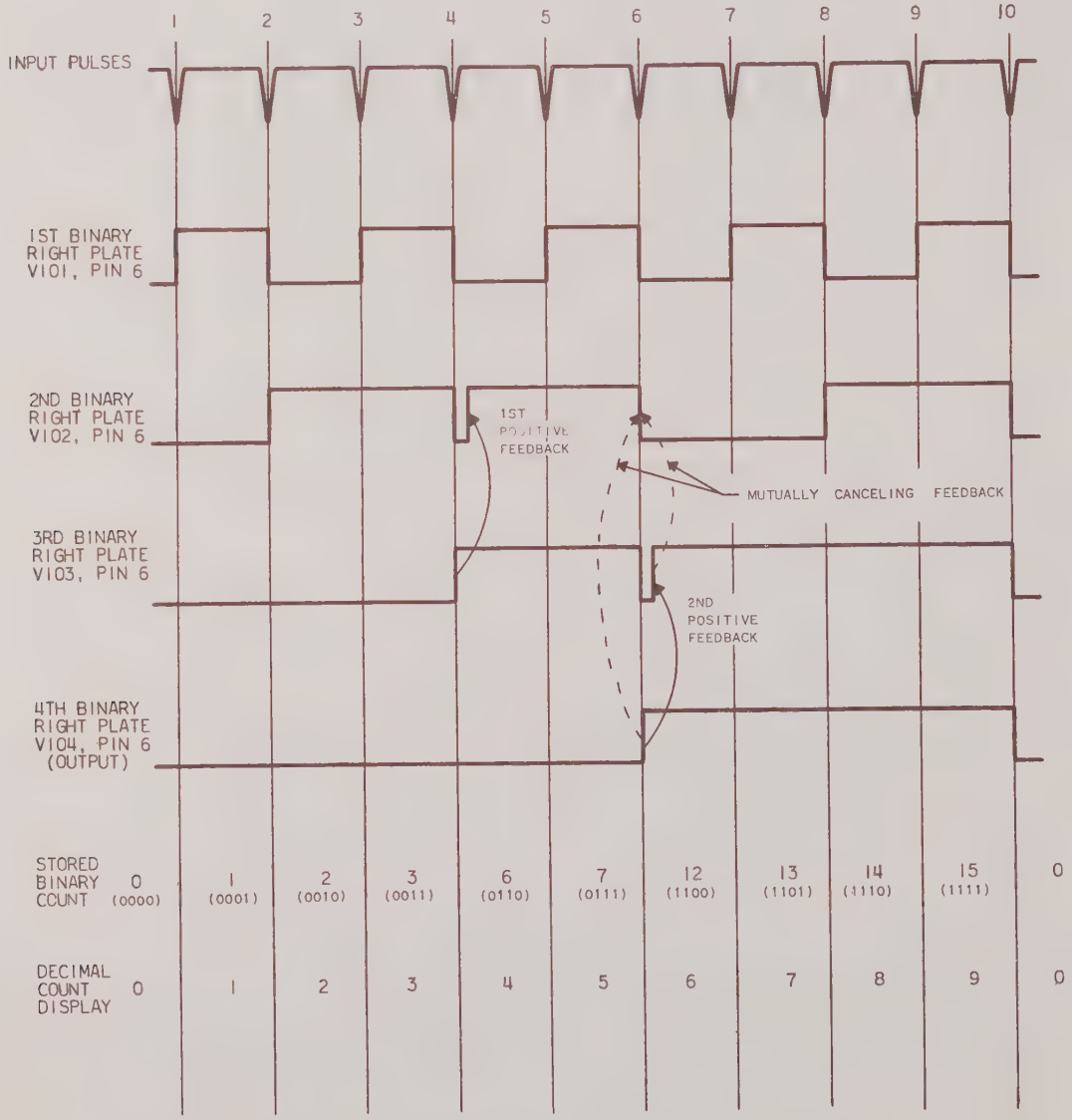


FIGURE 3. IDEALIZED WAVEFORMS. "RIGHT PLATE" REFERS TO THE PLATE APPEARING ON THE RIGHT-HAND SIDE OF THE BINARY AS DRAWN ON THE SCHEMATIC.

TROUBLESHOOTING PROCEDURES

When a decimal counting unit is suspected of counting incorrectly, it should be interchanged with another unit in the instrument or replaced with a spare unit to determine whether the trouble is in the suspected unit or in the associated circuitry. This test should be made very carefully. Because the counting unit is usually the indicating device of an instrument, it is often accused of operating incorrectly when the fault is external to it.

Two methods are recommended for locating a defect in a DCU. The first is to observe the lighting sequence while driving the unit at a slow pulse rate. The second is to study the output waveform of each binary while driving the unit fast enough to create an oscilloscope display. It is impossible to say which method should be used in every case, since marginal failures may occur at high counting speeds and not at lower counting rates, and vice versa. The first method is the only way that a neon lamp failure can be located, and it can be used to locate component and tube failures. For this reason, it is recommended that this method be used first. The table of common troubles lists the probable defects indicated by particular variations from the proper lighting sequence. Binary output waveforms may be compared with the idealized waveforms of Figure 3 and the photographs appearing in Figure 4 & 5.

A table of typical voltages and resistances has been provided to help the serviceman locate a defect within one of the binary stages. Values may deviate considerably from those given without causing trouble. The fact that the unit is designed to operate at plate supply voltages ranging from 200 to 400 volts is a rough indication of permissable tolerances.

TROUBLESHOOTING CHART

NOTE: Reset unit to zero before testing for symptoms

SYMPTOMS	POSSIBLE CAUSES
Unit Fails to Count	(a) Insufficient supply voltage. (b) Input signal of insufficient amplitude (c) Input signal of wrong polarity. (d) First stage inoperative.
Unit Counts Spuriously	(a) Extraneous input signals. (b) Pulses received through power supply. (c) External voltages picked up by output lead.
Unit Counts Erratically	(a) Input signal too large or small, incorrect rise time. (b) Supply voltage fluctuating too much.
Unit Fails to Reset	(a) Stray counts from reset switch or associated circuitry. (b) Defective component.

Unit counts regularly but neon bulbs light in wrong sequence and the pattern of lighting is repeated consistently after a definite number of input pulses. One or more bulbs may be lit simultaneously during a cycle but the number of states per cycle remains constant.

1. Unit skips every other number	(a) First stage defective. (b) Input circuit supplies double pulses.
2. Two stable states per cycle.	(a) Second stage defective (Display sequence may be 01 or 45). (b) Loss of drive to second stage (01).
3. Four stable states per cycle.	(a) Third stage defective (Display sequence may be 0123 or 6789). (b) Loss of drive to third stage (0123).
4. Six stable states per cycle.	(a) Output excessively loaded (Display sequence may be 012345). (b) Last stage inoperative (Display sequence may be 1 012345 or $67^{89}_{23}89$*. (c) Loss of drive to fourth stage (Display sequence may be 012345).
5. Eight stable states per cycle or any failure where two successive numbers are skipped.	(a) Second or third stage failure.
6. Ten stable states per cycle, but the lighting sequence is incorrect.	(a) When the wrong neon lamp lights, the trouble is usually a defect in the lamp that should have lit, but it may be a defect in the lamp that lit improperly. It's also possible that more than one lamp will light in place of the correct one.
7. Twelve stable states per cycle.	(a) When lighting sequence is $0123^{01}_{45}456789$* the cause may be a failure of the first feedback or lowered cathode emission in first or second binary. (b) When the lighting sequence is $01234567^{23}_{89}89$ the cause may be failure of the second feedback or low cathode emission in third or fourth binary.

* One digit above another means both lamps are lit.

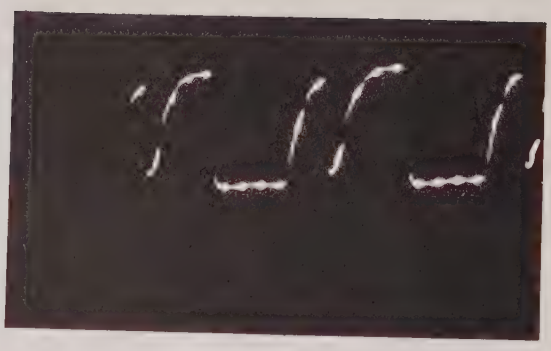
TABLE OF VOLTAGES & RESISTANCES

Tube	Pin No.	D-C Voltage with respect to B-.*	Resistance to B minus Terminal**
V101	1	170	105K
	2	17	85K
	3, 8	37	12K
	4, 5, 9	Filaments	
	6	60	105K
	7	37	85K
V102	1	135	93K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	
	6	55	93K
	7	30	83K
V103	1	135	100K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	
	6	55	100K
	7	30	83K
V104	1	135	93K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	
	6	55	93K
	7	30	83K

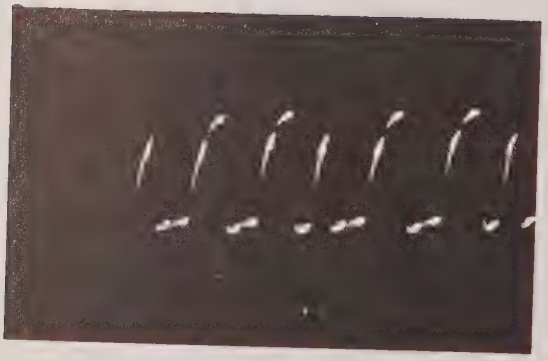
* Voltages measured in unit with 300-volt plate supply

** Before making resistance measurements jumper pins 3 and 8 on the DCU plug.

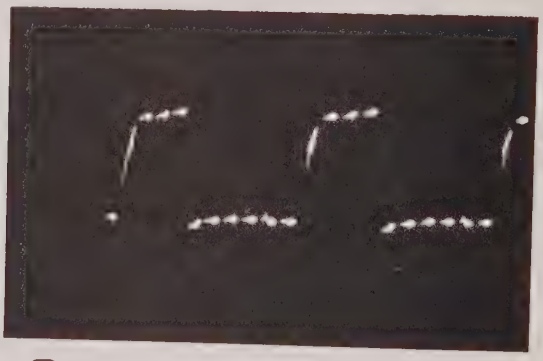
(1) First Binary Output (V101, Pin 6).
Upper voltage level is +168v
Lower voltage level is +55v



(2) Second Binary Output (V102, Pin 6)
Upper voltage level is +140v
Lower voltage level is +55v.

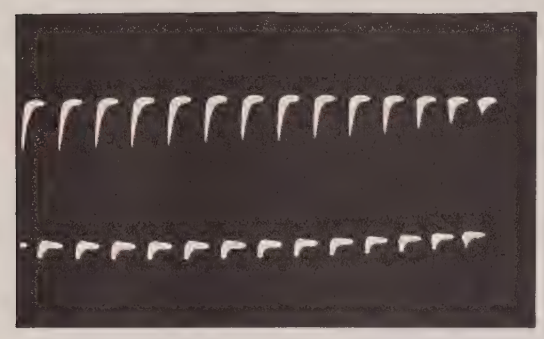


(3) Third Binary Output (V103, Pin 6)
Upper voltage level is +140v.
Lower voltage level is +55v.

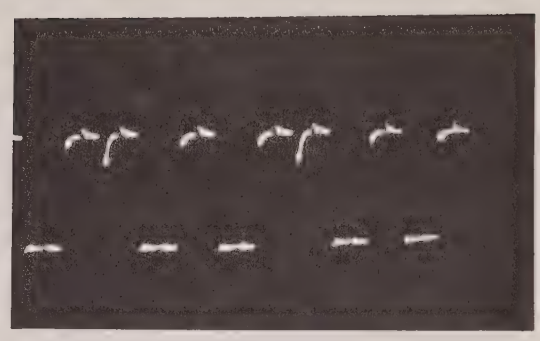


(4) Fourth Binary Output (V104, Pin 6).
Upper voltage level is +140v.
Lower voltage level is +55v.

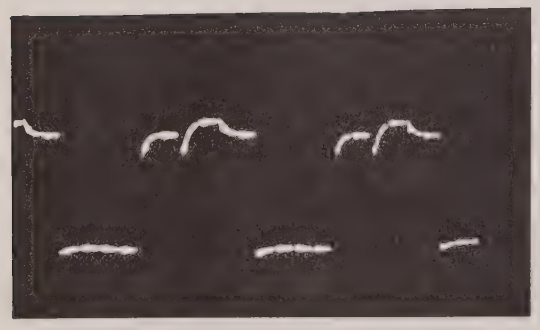
FIGURE 4. BLANKED WAVEFORMS AT INPUT FREQUENCY OF 100KC. ALL VOLTAGE LEVELS ARE MEASURED WITH RESPECT TO B MINUS.



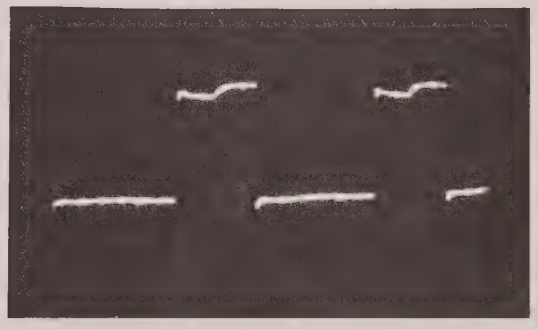
(1) First Binary Output (V101, Pin 6).
Upper Voltage level is +168V
Lower voltage level is +55v



(2) Second Binary Output (V102, Pin 6)
Upper voltage level is +140v
Lower voltage level is +55v.



(3) Third Binary Output (V103, Pin 6)
Upper voltage level is +140v.
Lower voltage level is +55v



(4) Fourth Binary Output (V104, Pin 6).
Upper voltage level is +140v.
Lower voltage level is +55v.

FIGURE 5. BLANKED WAVEFORMS AT INPUT FREQUENCY OF 20KC. ALL VOLTAGE LEVELS ARE MEASURED WITH RESPECT TO B MINUS.

COMPONENT LOCATION GUIDE

REFERENCE NO.	COMPONENT BOARD LOCATION		
	MODEL 775 FIG. 7	MODEL 775 AJ FIG. 9	MODEL 775 K FIG. 11
C101	B 17	B 17	B 17
C102	B 18	B 18	B 18
C103	C 12	C 12	C 12
C104	C 7	C 7	C 7
C105	A 19	A 19	A 19
C106	A 21	A 21	A 21
C107	A 13	A 13	A 13
C108	A 15	A 15	A 15
C109	A 8	A 8	A 8
C110	A 10	A 10	A 10
C111	A 3	A 3	A 3
C112	A 5	A 5	A 5
C113*	A 17	A 17	A 17
C114*	A 12	A 12	A 12
C115*	A 7	A 7	A 7
C116*	A 2	A 2	A 2
C117	B 8	B 8	B 8
C118	C 6	C 6	C 6
C119	B 12	B 12	B 12
C120	-	D 2	-
CR101	-	D 20	D 20
CR102	-	D 18	D 19
R101	D 21	D 21	D 21
R102	D 17	D 17	D 17
R103	D 16	D 16	D 16
R104	D 15	D 15	D 15
R105	D 14	D 14	D 14
R106	D 13	D 13	D 13
R107	D 11	D 11	D 11
R108	D 8	D 8	D 8
R109	D 6	D 6	D 6
R110	D 5	D 5	D 5
R111	D 4	D 4	D 4
R112	D 3	D 3	D 3
R113	C 19	C 19	C 19
R114	C 14	C 14	C 14
R115	C 9	C 9	C 9
R116	C 4	C 4	C 4
R117	C 20	C 20	C 20
R118	C 17	C 17	C 17
R119	C 21	C 21	C 21
R120	C 18	C 18	C 18
R121	C 16	C 16	C 16
R122	C 13	C 13	C 13
R123	C 11	C 11	C 11
R124	C 8	C 8	C 8
R125	C 5	C 5	C 5
R126	C 3	C 3	C 3
R127	A 18	A 18	A 18
R128	A 20	A 20	A 20
R129	A 14	A 14	A 14
R130	A 16	A 16	A 16
R131	A 9	A 9	A 9
R132	A 11	A 11	A 11
R133	A 4	A 4	A 4
R134	A 6	A 6	A 6
R135	B 19	B 19	B 19
R136	B 20	B 20	B 20
R137	B 14	B 14	B 14
R138	B 15	B 15	B 15
R139	B 9	B 9	B 9
R140	B 10	B 10	B 10
R141	B 4	B 4	B 4
R142	B 5	B 5	B 5
R143	A 17	A 17	A 17
R144	A 12	A 12	A 12
R145	A 7	A 7	A 7
R146	A 2	A 2	A 2
R147	B 13	B 13	B 13
R148	C 10	C 10	C 10
R149	D 2	-	-
R150	D 7	-	D 7
R151	D 12	-	D 12
R152	D 18	-	D 18
R162	B 6	B 6	B 6

*Reverse side of board

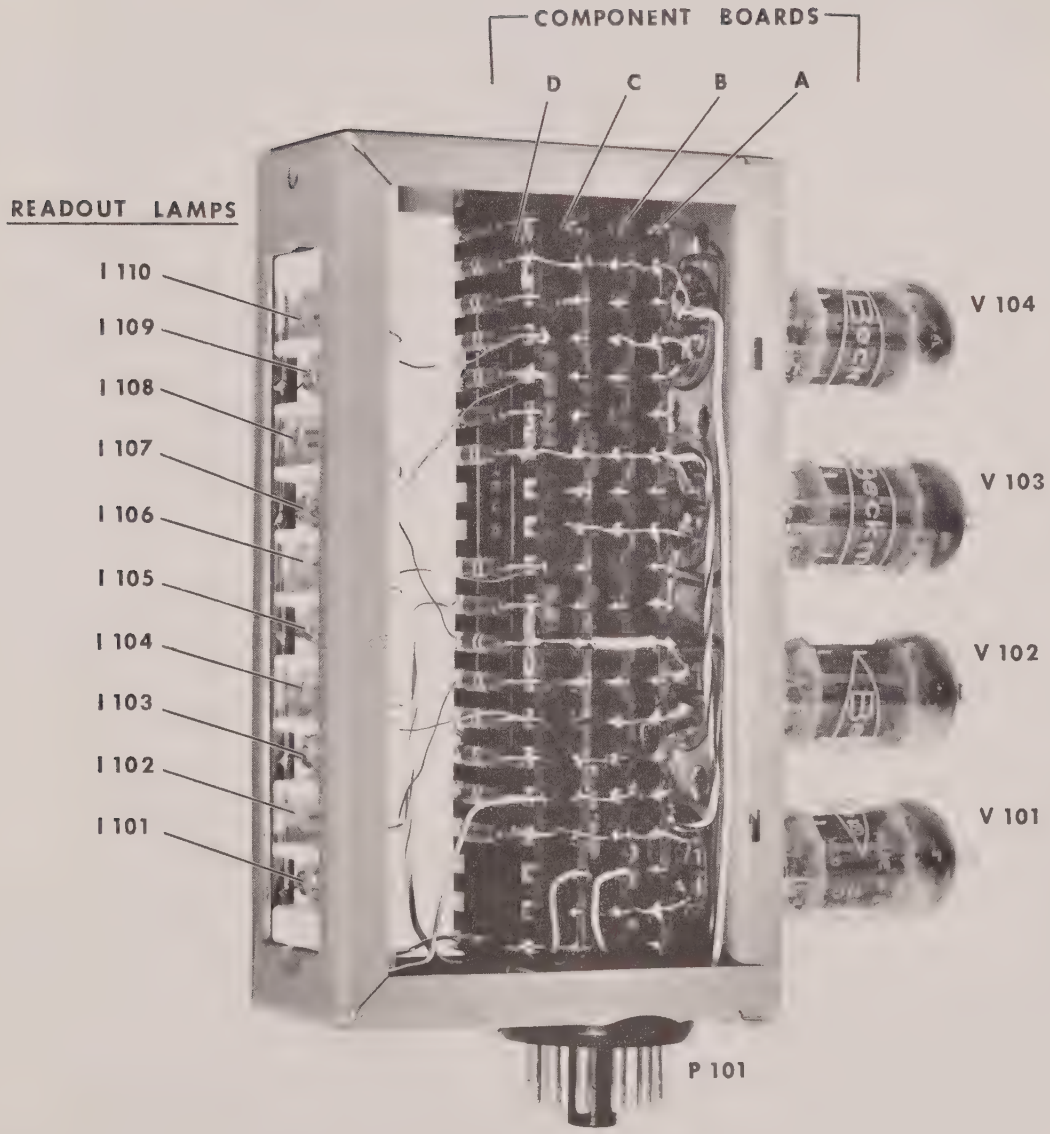


FIGURE 6. MODEL 775 DCU WITH NUMBER MASK REMOVED.

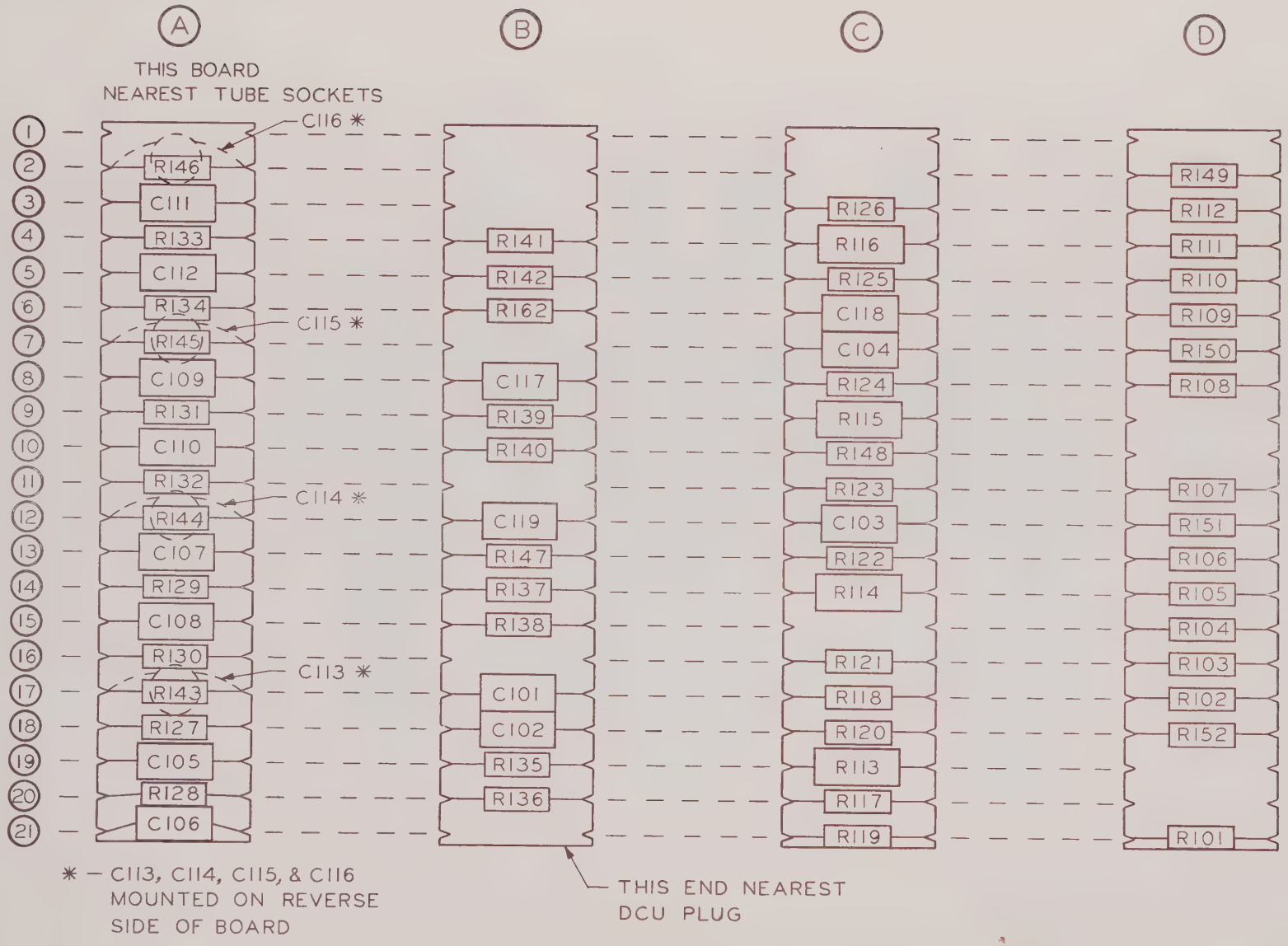
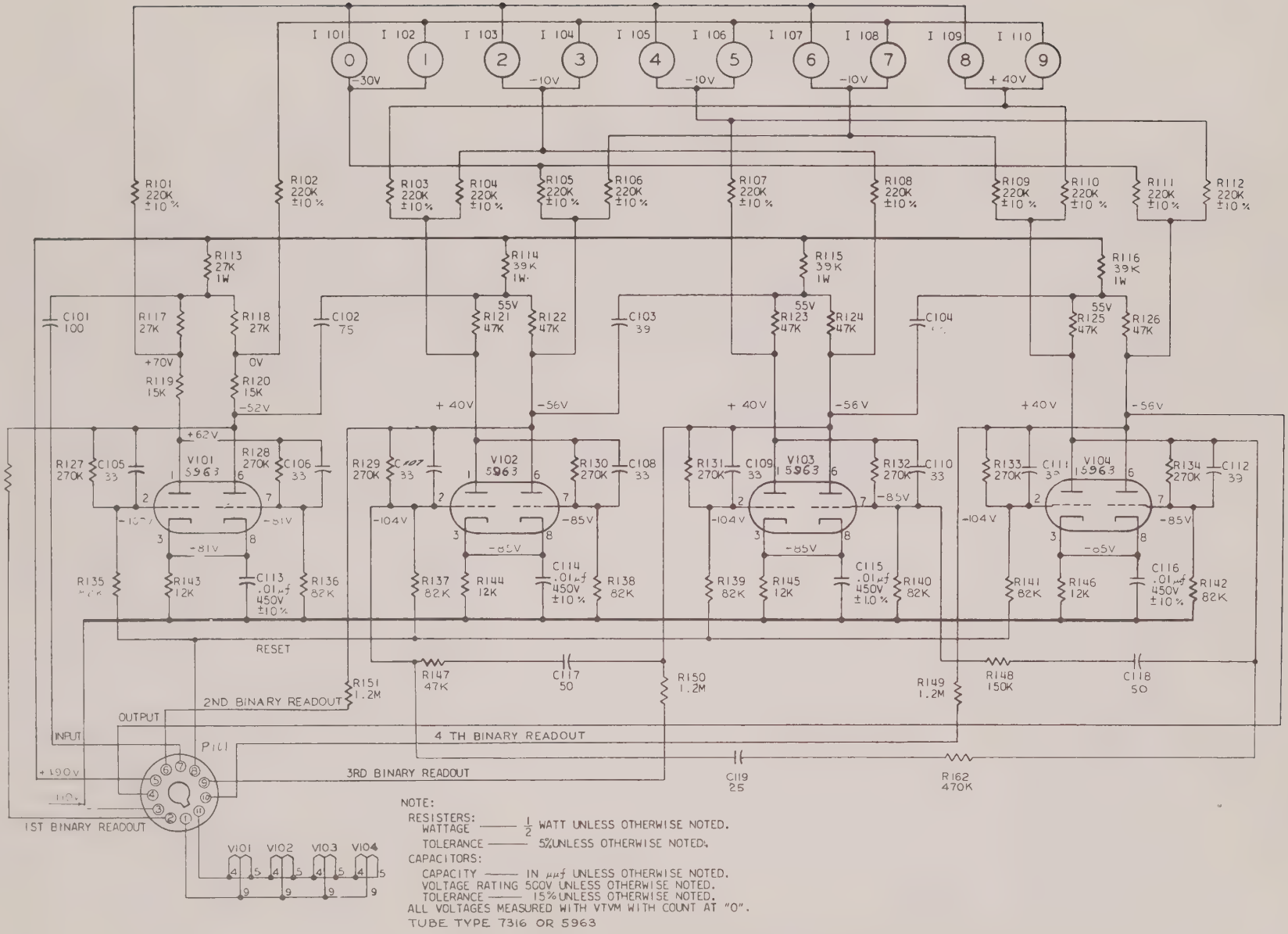


FIGURE 7. MODEL 775 COMPONENT BOARD LAYOUT.



NOTE:
RESISTERS: WATTAGE —— $\frac{1}{2}$ WATT UNLESS OTHERWISE NOTED.
TOLERANCE —— 5% UNLESS OTHERWISE NOTED.
CAPACITORS:
CAPACITY —— IN μμf UNLESS OTHERWISE NOTED.
VOLTAGE RATING 500V UNLESS OTHERWISE NOTED.
TOLERANCE —— 15% UNLESS OTHERWISE NOTED.
ALL VOLTAGES MEASURED WITH VTVM WITH COUNT AT "0".
TUBE TYPE 7316 OR 5963

FIGURE 8. MODEL 775 SCHEMATIC DIAGRAM.

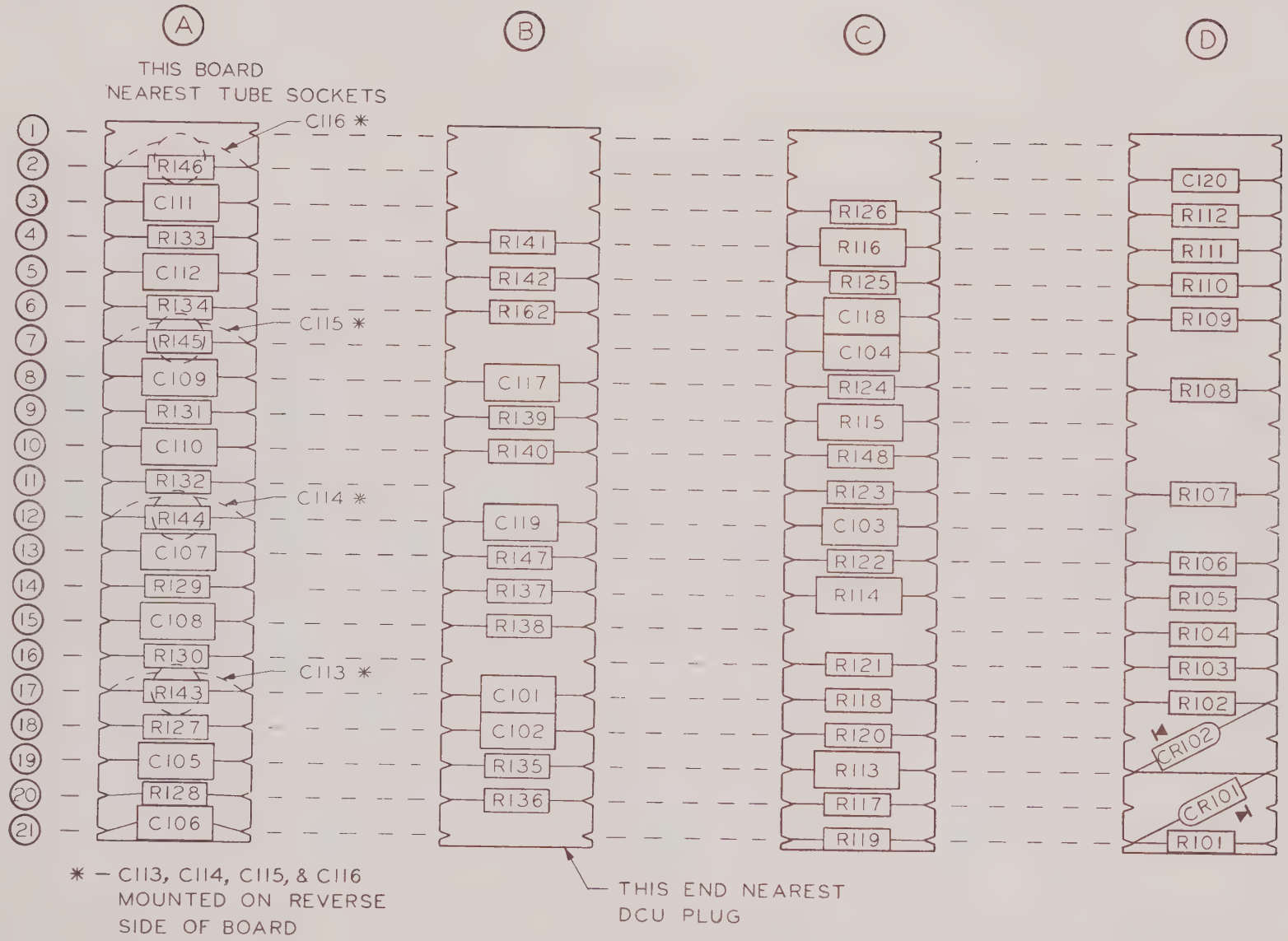
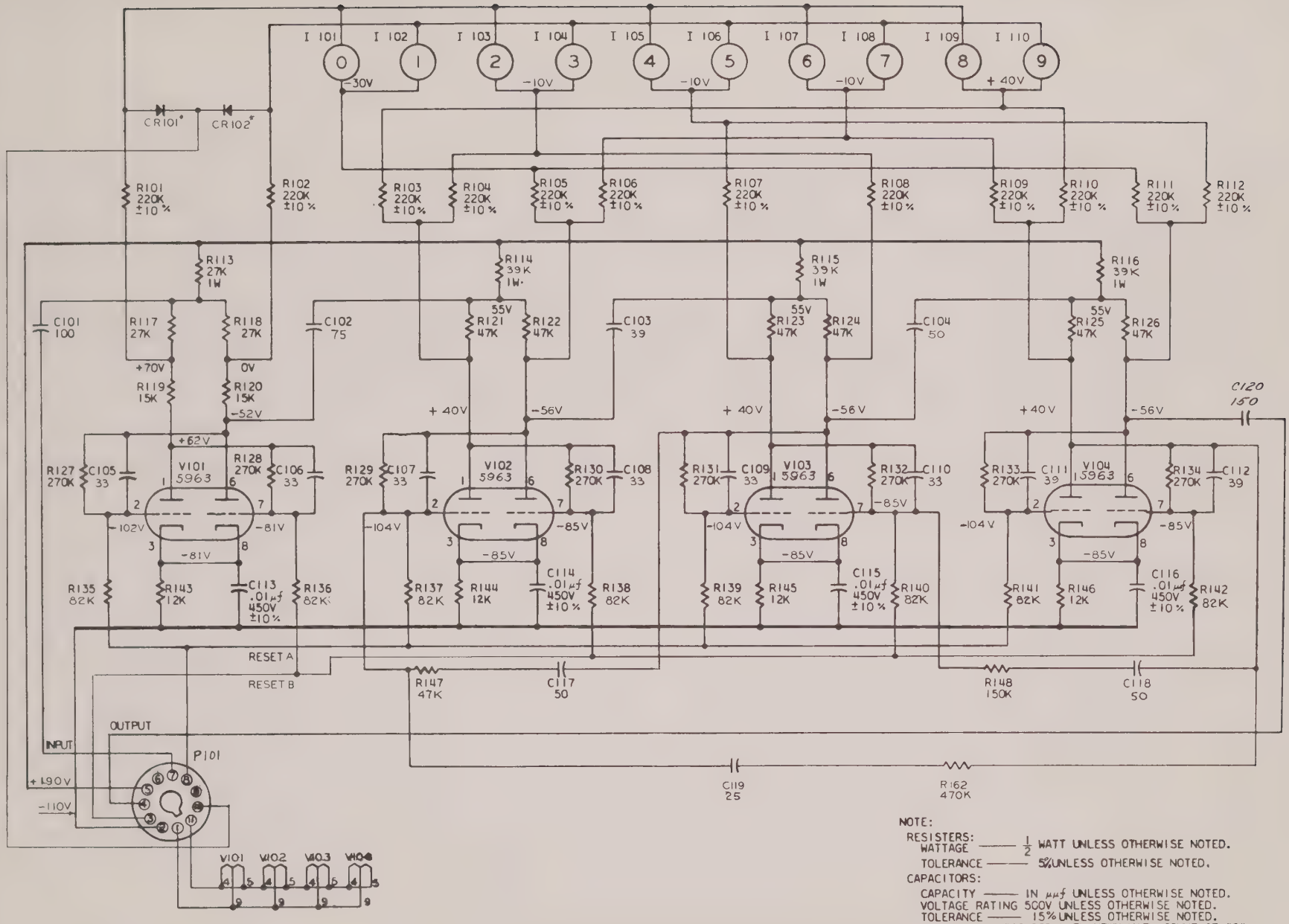


FIGURE 9. MODEL 775AJ COMPONENT BOARD LAYOUT.



NOTE:
RESISTERS: WATTAGE —— $\frac{1}{2}$ WATT UNLESS OTHERWISE NOTED.
TOLERANCE —— 5% UNLESS OTHERWISE NOTED.
CAPACITORS:
CAPACITY —— IN μμf UNLESS OTHERWISE NOTED.
VOLTAGE RATING 500V UNLESS OTHERWISE NOTED.
TOLERANCE —— 15% UNLESS OTHERWISE NOTED.
ALL VOLTAGES MEASURED WITH VTVM WITH COUNT AT "0".
& PIN 10 DISCONNECTED

* CR101 & CR102 ARE GE. NO. 6RSIGH3TM1.

FIGURE 10. MODEL 775AJ SCHEMATIC DIAGRAM.

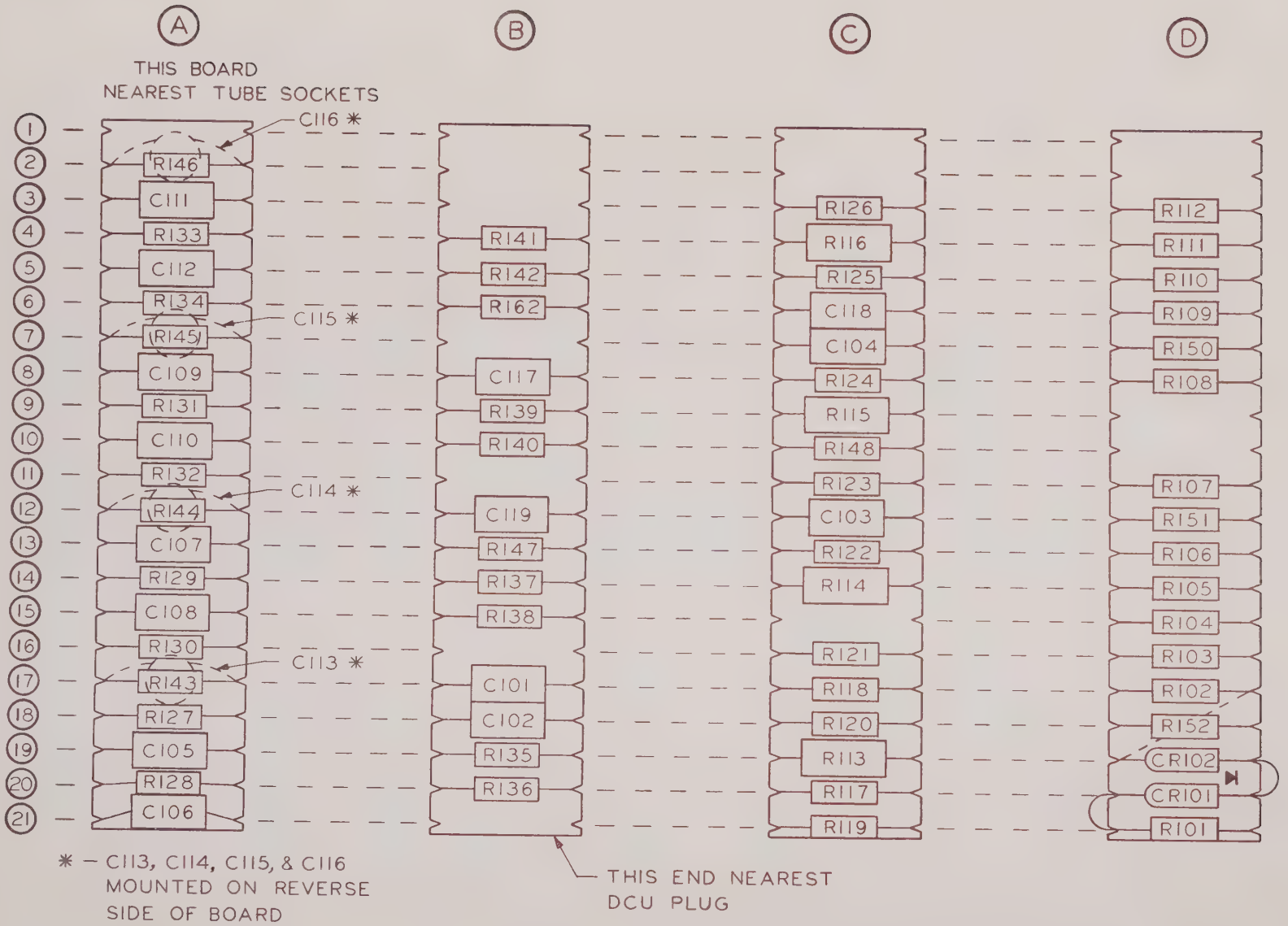


FIGURE 11. MODEL 775K COMPONENT BOARD LAYOUT.

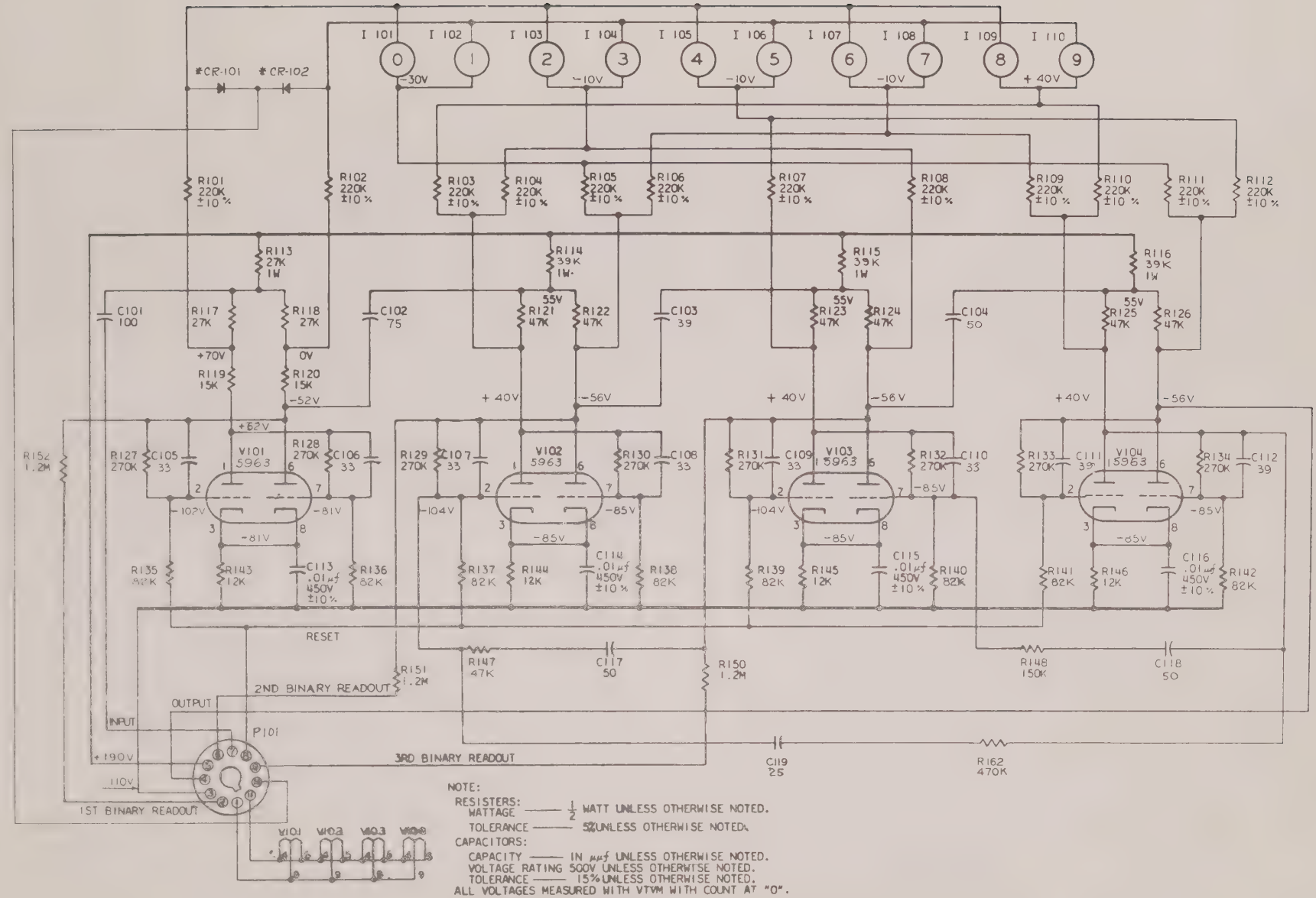
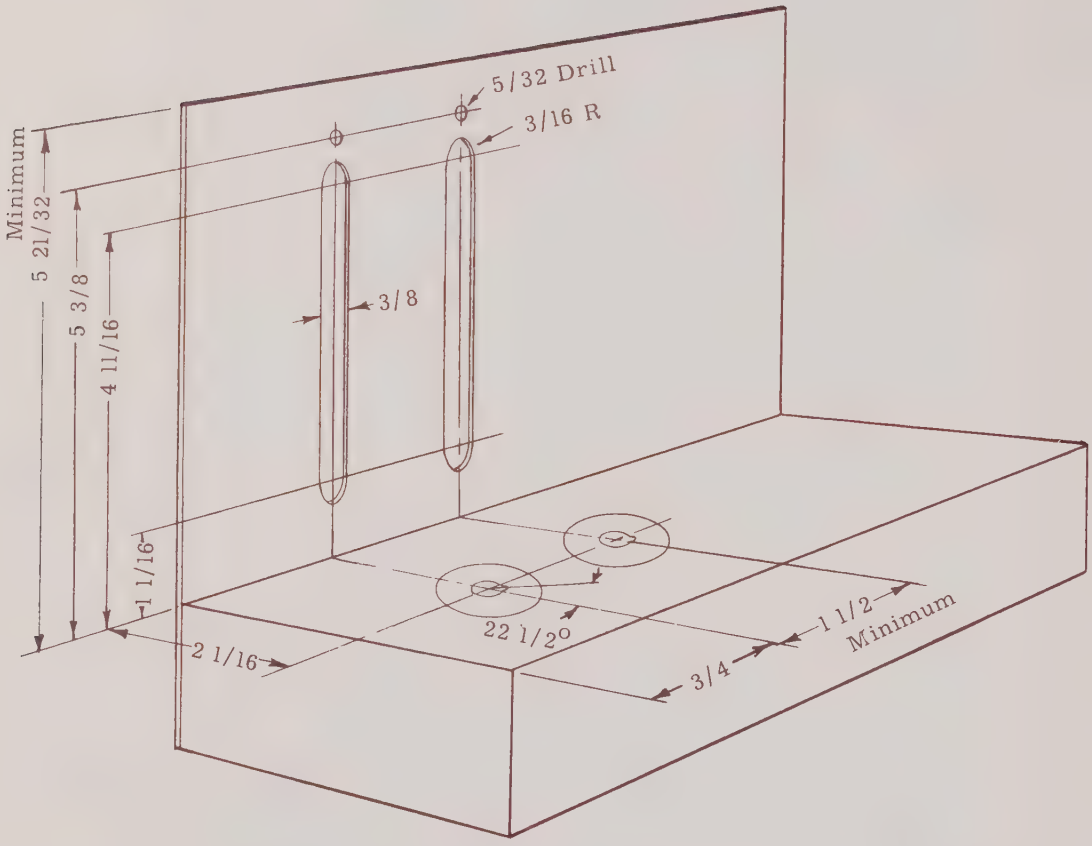


FIGURE 12. MODEL 775K SCHEMATIC DIAGRAM.



NOTE: Dimensions are based on the use of an Amphenol "MIP" 8 or 11-pin socket mounted above the chassis.

FIGURE 13. MOUNTING DIMENSIONS FOR MODEL 775, 775AJ, AND 775K.

Instruction Manual

MODEL 785A
DECIMAL COUNTING UNIT

Beckman
Berkeley Division
2800 Wright Avenue, Richmond 8, California
a division of Beckman Instruments, Inc.

1960

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in posession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

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BECKMAN INSTRUMENTS, INC.

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Model 785A Schematic Diagram, Dwg. No. 785 D 300

GENERAL DESCRIPTION

The Model 785A is a direct-reading, plug-in decimal counting unit. A decimal counting unit (DCU) registers voltage pulses applied at an input. Starting from zero it counts to nine, returning to zero on the tenth pulse and simultaneously generating an output signal. The count score is indicated by the illumination of one of ten neon lights placed behind a numbered acetate panel. This unit will count at a maximum rate of 1, 100, 000 pulses per second. This output is suitable for driving a Model 775 DCU or any modification of it (775AJ, 775K, etc.) except a 775LJ. Decimal counting units may be connected in cascade (output of one to input of next), thus forming a counter whose total capacity depends only on the number of units in the chain. For example, a chain consisting of one 785A followed by five 775's will count to 999, 999, returning to "000, 000" on the 1, 000, 000th input pulse.

The unit also generates a binary-coded decimal readout in the form of high or low voltages at each of four pins on the DCU plug.

SPECIFICATIONS

Count Indication

Illuminated decimal digits

Input Requirements

Negative pulses. (See "OPERATION")

Resolution of Paired Pulses

0.8 microseconds

Maximum Counting Rate

1, 100, 000 counts per second

Output Characteristics

Designed to drive a Model 775 DCU or any modification of it except a 775LJ. (See "OPERATION".)

NOTE: The 785A will also drive the 705 series DCU's since the latter are interchangeable with the 775 series.

Reset

Reset to zero by negative pulse applied to pin 8 of plug.

Power Requirements

Heaters: 6.3V a-c at 1.8 amps near ground potential.

Plates

175 to 260 volts. (Design center is 210 volts at 45 ma.)

Construction

Plug-in unit which fits into standard 11-pin tube socket.

Dimensions

1-3/8" by 5" by 5-3/8"

Weight

1 pound

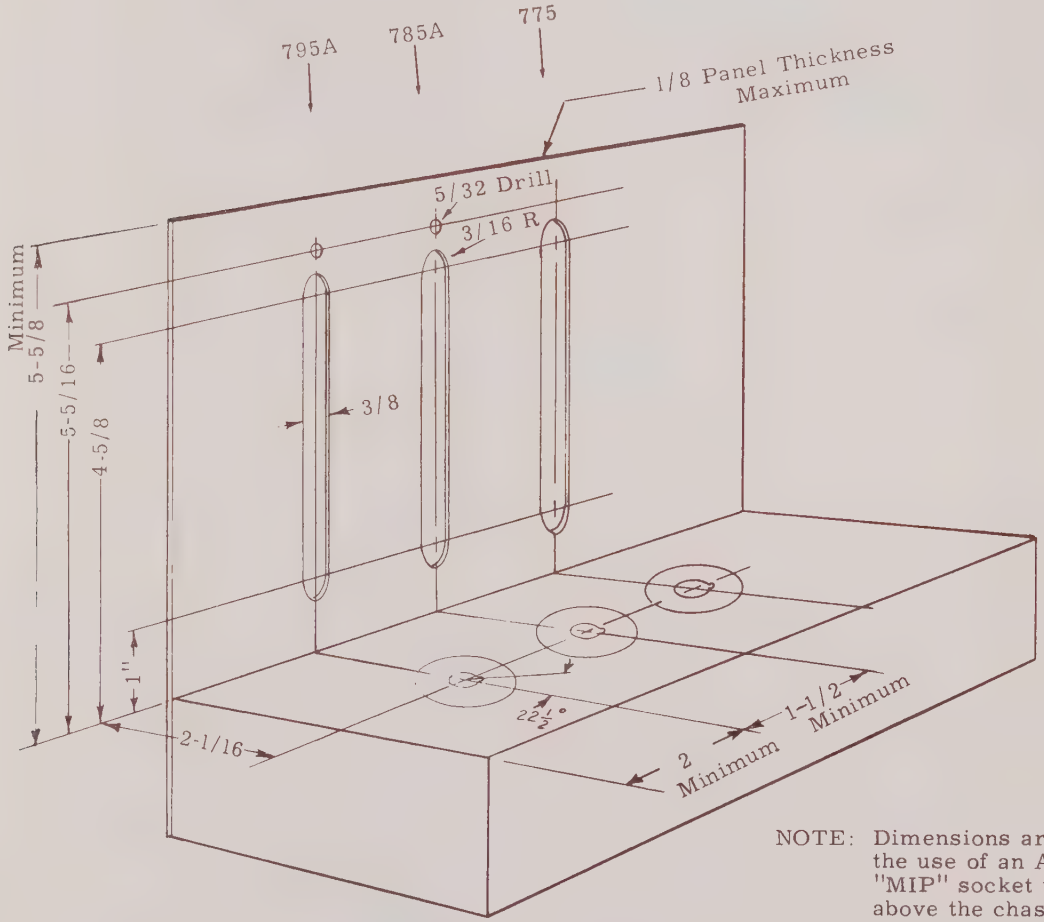
Tube Complement

Four type 12AV7.

INSTALLATION AND OPERATION

When purchased as part of another instrument, the decimal counting units are fully installed and ready to function. DCU's purchased separately should be installed and operated in accordance with the directions that follow.

Mounting. Figure 1 shows the dimensions of a chassis suitable for mounting one of these DCU's together with a Model 795A (10MC) and a Model 775 (100KC).



NOTE: Dimensions are based on the use of an Amphenol "MIP" socket mounted above the chassis.

The drawing shows the chassis dimensions for mounting Models 795A, 785A, and 775 DCU's side by side. Spacing between all units (or additional units) is identical.

FIGURE 1.

MOUNTING DIMENSIONS FOR MODEL 785A OR 795A DECIMAL COUNTING UNIT

INPUT REQUIREMENTS

A negative pulse of 7 volts peak amplitude is required to trigger the unit. The rise time should be less than 0.12 microseconds, and the duration at least 0.25 microseconds. When the unit is powered by an unregulated supply, the drive amplitude should be proportional to the actual B+ voltage.

OUTPUT CHARACTERISTICS

The output is a rectangular waveform as shown in Figure 4. It is represented at the output terminal as a change in direct current voltage level. During count display "0" thru "3" it is 115 volts; during count display "4" thru "9", 205 volts. Ordinarily, the 90-volt negative transient produced at the count of ten drives the following decimal counting unit.

The load imposed on a unit must not be more than a 27,000 ohm resistor in series with a 39 $\mu\mu$f capacitor to ground.

METHOD OF RESET

Regardless of the number of units, all may be set back to zero by applying a negative pulse to a common line connected to pin 8 of the 11-pin socket.

BINARY CODE READOUT

The output at pins 2, 6, 9, and 10 of the DCU plug may be used to operate another binary coded readout or printing device. Refer to the Binary Readout Code table on page 6 to learn the relationship between binary digits and plug terminal pins.

CIRCUIT DESCRIPTION

THE BINARIES

The Model 785A DCU contains four "flip-flop" circuits referred to here as binaries. These circuits are modifications of the Eccles-Jordan trigger circuit.

Figure 2 shows a typical binary. It consists of two triode voltage amplifiers with the plate of each direct-coupled to the grid of the other. With no input this circuit assumes one of two stable states: V1 conducting steadily and V2 cut off, or V2 conducting and V1 cut off. Suppose V1 is not conducting; then its plate is near the B+ voltage. A portion of this voltage, applied to the grid of V2 through the voltage dividing network R4 and R8, raises this grid above cutoff and permits V2 to conduct. While V2 is conducting, the low positive potential at its plate, coupled to the grid of V1 through the dividing network R3 and R7, holds this grid several volts below cutoff. Since small changes in the potential at the grid

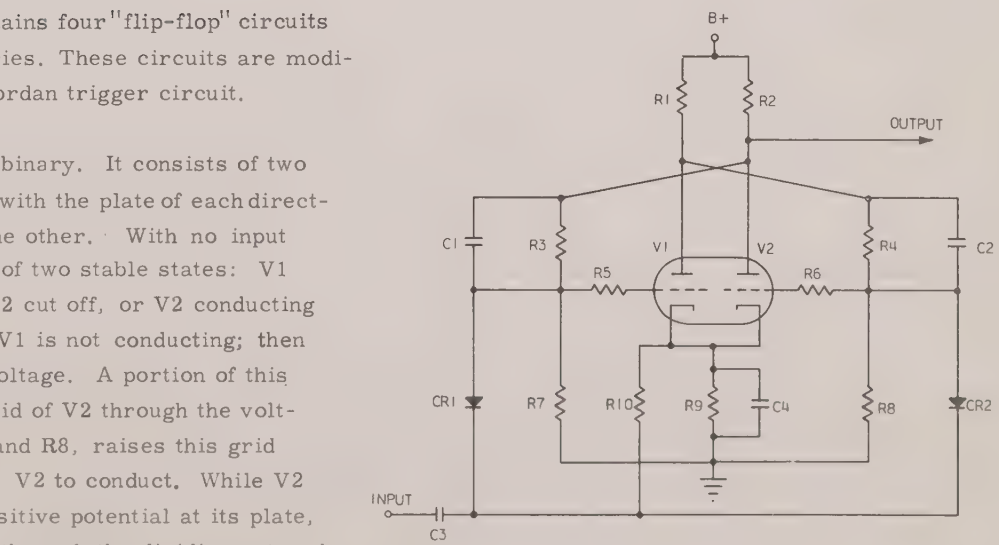


FIGURE 2.

A TYPICAL BINARY STAGE

of V1 will not raise it above cutoff, this state is stable and will persist until disturbed by an appreciable input signal. Notice that, since the circuit is symmetrical, the opposite state is equally stable.

The circuit is triggered from one state to another by negative transients applied at the input. The input diodes CR1 and CR2 form a gating system which couples the pulse formed at C3 to the grid of the conducting triode but blocks it from the grid of the other triode. Suppose, as before, that V1 is cut off and V2 is conducting. The diode side of C3 will carry a potential of about 40 volts (the same as that on the grid of V2). An applied transient will cause this potential to drop momentarily toward 30 volts. CR1 will not conduct since its plate is negative of 30 volts. However CR2 will conduct and the negative transient at the grid of V2 will lower tube current and cause an amplified rise in plate voltage. This rise will carry the grid of V1 above cutoff. The moment V1 conducts, the drop in voltage at its plate, coupled to the opposite grid, reinforces the negative transient there. This regenerative action proceeds rapidly until V2 is cut off and V1 is conducting at a steady rate. The next adequate input transient causes a reverse action and returns the binary to its original state. Thus, the binary completes a cycle for every two input transients applied, making it a scale of two. The output is the drop in voltage at one of the plates as that triode begins to conduct. This output, consisting of one negative transient for every two input transients, is suitable for driving another binary. By connecting binaries in cascade (output of one to input of the next), a counter having a scale of any power of two can be built. A chain of three cascaded binaries would be a scale-of-eight (2^3). If we call the input pulses driving such a chain "counts", the operation may be described as follows. The first binary will produce a negative pulse upon counts 2, 4, 6 and 8. The second binary will generate output pulses at counts 4 and 8, and the third binary will produce a pulse only at count 8. Count 8 completes a full cycle; the binaries will then be in the same state they were in before the first count.

THE SCALE OF TEN

In the Model 785A three binaries are connected in cascade to form a scale of eight. A fourth binary is arranged to block the input to the second binary during two input pulses to the counter, so that ten rather than eight pulses are required to produce a complete cycle. Figure 3 is a block diagram of the circuit.

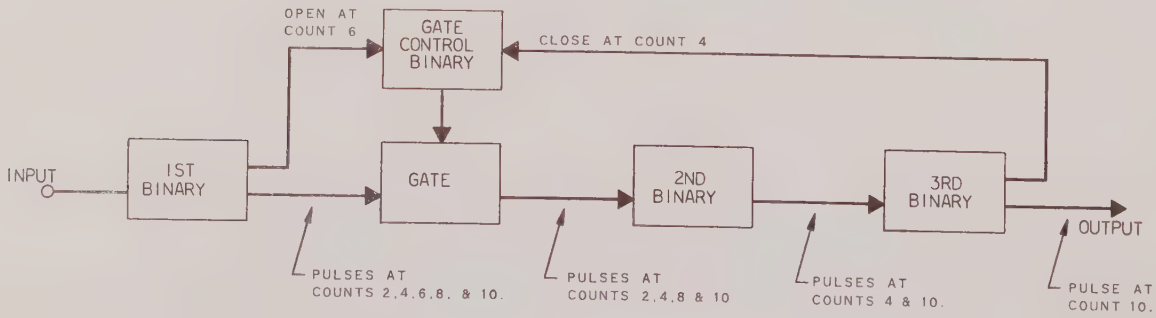


FIGURE 3.
BLOCK DIAGRAM OF MODEL 785A DCU

At the beginning of a cycle the gate control binary is in the state which holds the gate open. For the first three counts (that is, counts "1" through "3") the unit operates like a simple binary counter. At count 4 the third binary is triggered for the first time and, in turn triggers the gate control binary to its other state, closing the gate. The gate is closed during counts 5 and 6. At count 6 the first binary produces an output pulse which triggers the gate control binary back to the "open" state. During counts 7, 8, 9, and 10 the unit again operates like a simple binary chain. At count 10 the third binary produces a negative output transient which will drive another decimal counting unit.

TABLE 1

Count Display	State of Each Binary Stage			
	4th	3rd	2nd	1st
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	1	1	0	0
5	1	1	0	1
6	0	1	0	0
7	0	1	0	1
8	0	1	1	0
9	0	1	1	1
0	0	0	0	0

The operating sequence of the DCU is summarized in Table 1 which shows the state of each binary for each registered count score. The state of a binary is defined by whether or not triode B is conducting. "0" means triode B is conducting; "1" means triode B is cut off.

Figure 4 shows how voltages throughout the unit change as successive input pulses are received. Voltages are identified by circled reference points located on the schematic diagram. The output voltage used to drive succeeding binaries is taken from the junction of two plate load resistors in the right-hand triode circuit rather than from the plate itself.

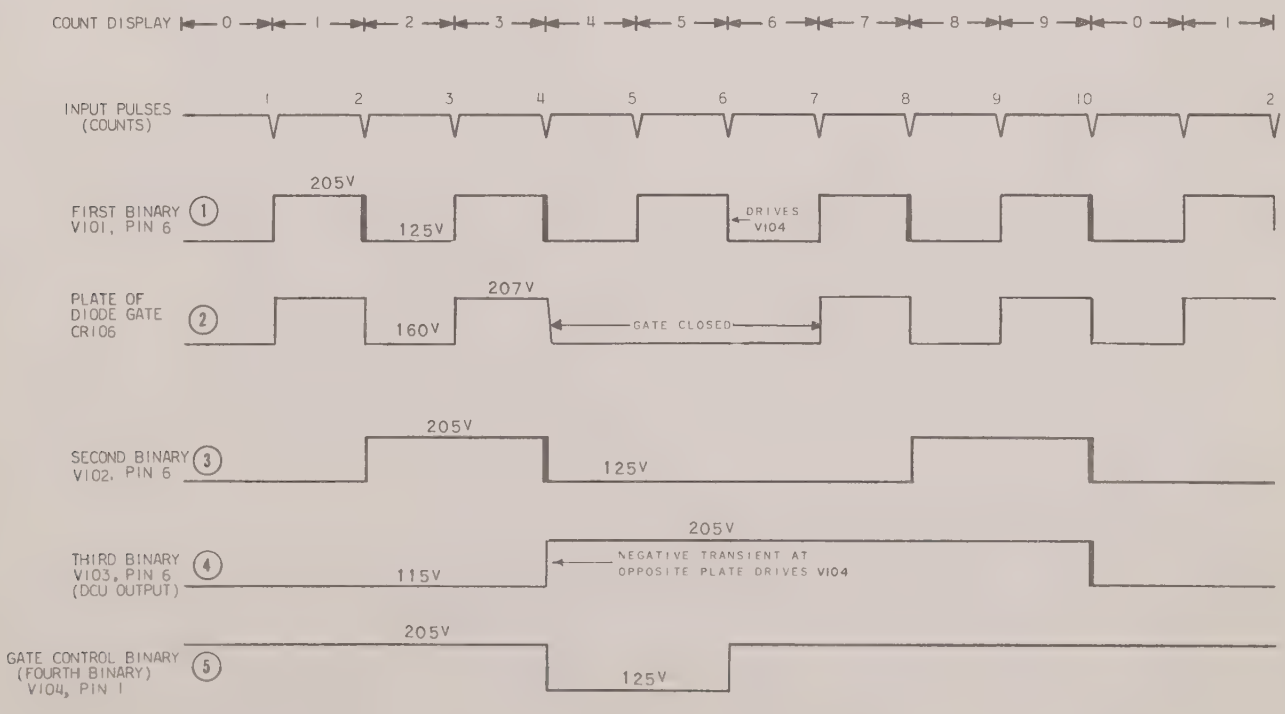


FIGURE 4.

IDEALIZED WAVEFORMS

The waveforms at this junction are identical to the plate waveforms shown in Figure 4, but of smaller amplitude. The negative transients (shown in heavy lines in Figure 4) drive succeeding binaries. The negative transient from the first binary which occurs at count 6 does not reach the second binary because of the action of the gate diode CR106 described in the paragraph "Gate Control Circuit".

Actual oscilloscope waveforms are shown in Figure 8. Each photograph has a number corresponding to the point on the schematic diagram where the waveform was observed.

BINARY CODE READOUT

The output voltages of each binary are also brought out to pins 2, 6, 9 and 10 of the DCU plug to operate auxiliary binary-coded readout devices. Observe that voltage at pin 6 combines the output of the second binary and the output of the right half of the fourth binary while the voltage at pin 10 combines the output of the third binary with that of the left half of the fourth binary. The resultant modified binary code given in Table 2 below agrees with that generated by other Beckman instruments. In the table, "0" represents a voltage of -15 volts or more negative; "1" represents a voltage at ground level or more positive.

TABLE 2. BINARY READOUT CODE

Count Display	Pin on DCU Plug			
	10	9	6	2
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	1	0
5	0	1	1	1
6	1	1	0	0
7	1	1	0	1
8	1	1	1	0
9	1	1	1	1
0	0	0	0	0

GATE CONTROL CIRCUIT

At count 4, the voltage at the right plate of the third binary (Point (4) on the schematic) rises. At the same time, the voltage at the left plate drops. The negative transient produced at the left plate is coupled to the right grid of the gate control binary (V104), causing it to switch to the state in which the left triode conducts. (Point (5)). The resultant voltage drop across R119 causes the plate of the diode gate (CR106) to drop to +160v. (Point (2)). At this time the diode plate voltage is equal to its cathode voltage, which varies between +207v and +160v. The diode does not conduct and therefore prevents the negative output transient at count 6 from reaching the second binary. However, the negative output pulse of V101 is coupled through C104 to the left grid of the control binary which is now above cutoff. This switches the control binary back to its original stable state, opening the gate to pass a trigger pulse to the second binary at count 8.

OUTPUT CIRCUITRY

As the DCU cycles through counts "1" to "10", ten discreet combinations of binary states are produced, corresponding to the binary code given in the table on the preceding page. The output voltage of binaries #2 through #4 is at one of two levels which we shall designate "high" or "low". The outputs are connected to the neon bulbs in a matrix using diodes so that if one lamp terminal is connected to a low potential the voltage at that point will remain low regardless of the output level of another binary which may be connected to the same terminal. The output voltage of binary #1 is either "low" or "intermediate" because the voltage divider networks in the plate circuits prevent the voltage from reaching the "high" level.

At count "1" lamp No. 1 has both high and low potentials existing at its terminals. The circuit can be analyzed as in Figure 5 for each count of the cycle in order to verify that this condition will exist for only one neon bulb at each count.

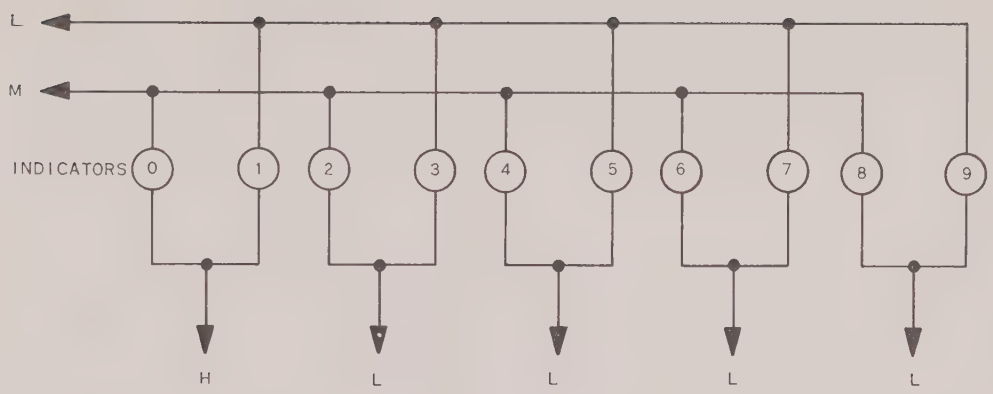


FIGURE 5.

VOLTAGE LEVELS ACROSS NEON BULBS EXISTING AT COUNT ONE
(H = HIGH, M = INTERMEDIATE, L = LOW)

SERVICING

When a Decimal Counting Unit is suspected of counting incorrectly, it should be interchanged with a spare unit to determine whether the trouble is in the suspected unit or in the associated circuitry. This test should be made very carefully. Since the counting unit is usually the indicating device of a larger instrument, faulty operation is often ascribed to it when the symptoms of external faults are displayed.

TROUBLESHOOTING

Two methods are recommended for finding the trouble in a faulty counting unit. First, by observing the lighting sequence while driving the unit at a slow repetition rate, and second, by studying the waveform of each stage while driving the unit at a repetition rate fast enough to be conveniently viewed on an oscilloscope. It is impossible to say which method should be used in every case, since marginal failures may occur at high counting speeds and not at lower counting rates, and vice versa. The first method is the only way that a neon lamp failure can be located, and it can be used to locate component and tube failures. For this reason, it is recommended that this method be used first.

The Troubleshooting Chart (Table 3) lists some common troubles which may be readily localized by observing the lighting patterns. Figure 8 shows actual oscilloscope waveforms to be used for comparison. Voltage and resistance measurements at tube pins are given in Table 5.

It will be found that most failures are caused by faulty tubes.

TABLE 3

TROUBLESHOOTING CHART

NOTE: Reset unit before troubleshooting

Symptom	Cause
Unit fails to count	(a) Insufficient supply voltage
	(b) Input signal of insufficient amplitude
	(c) Input signal of wrong polarity
	(d) First stage inoperative
Unit counts spuriously	(a) Stray input signal
	(b) Pulses received through power supply
	(c) External voltages picked up by output lead
Unit counts erratically	(a) Input signal too large or small, incorrect rise time
	(b) Supply voltage fluctuating too much
Unit fails to reset	(a) Stray counts from reset switch or associated circuitry
	(b) Defective component

Symptom	Cause
Unit counts in wrong sequence	
1. Skips every other number	(a) First stage defective
	(b) Input circuit supplies double pulses
2. Skips 4 and 5	(a) 4th stage not being driven by the 3rd
3. Skips 6 and 7	(a) Defective gate diode (CR106)
Repeats a pattern of numbers	
1. Two stable states per cycle (0-1 or 2-3, etc.)	(a) 2nd stage not being driven
2. Four stable states per cycle (0-1-2-3 or 6-7-8-9)	(a) 3rd stage not being driven
3. Counts up to 5, then alternates between 4-5	(a) 4th stage not being driven by the 1st
Two lamps light simultaneously	Defective diode (CR101 to CR105)

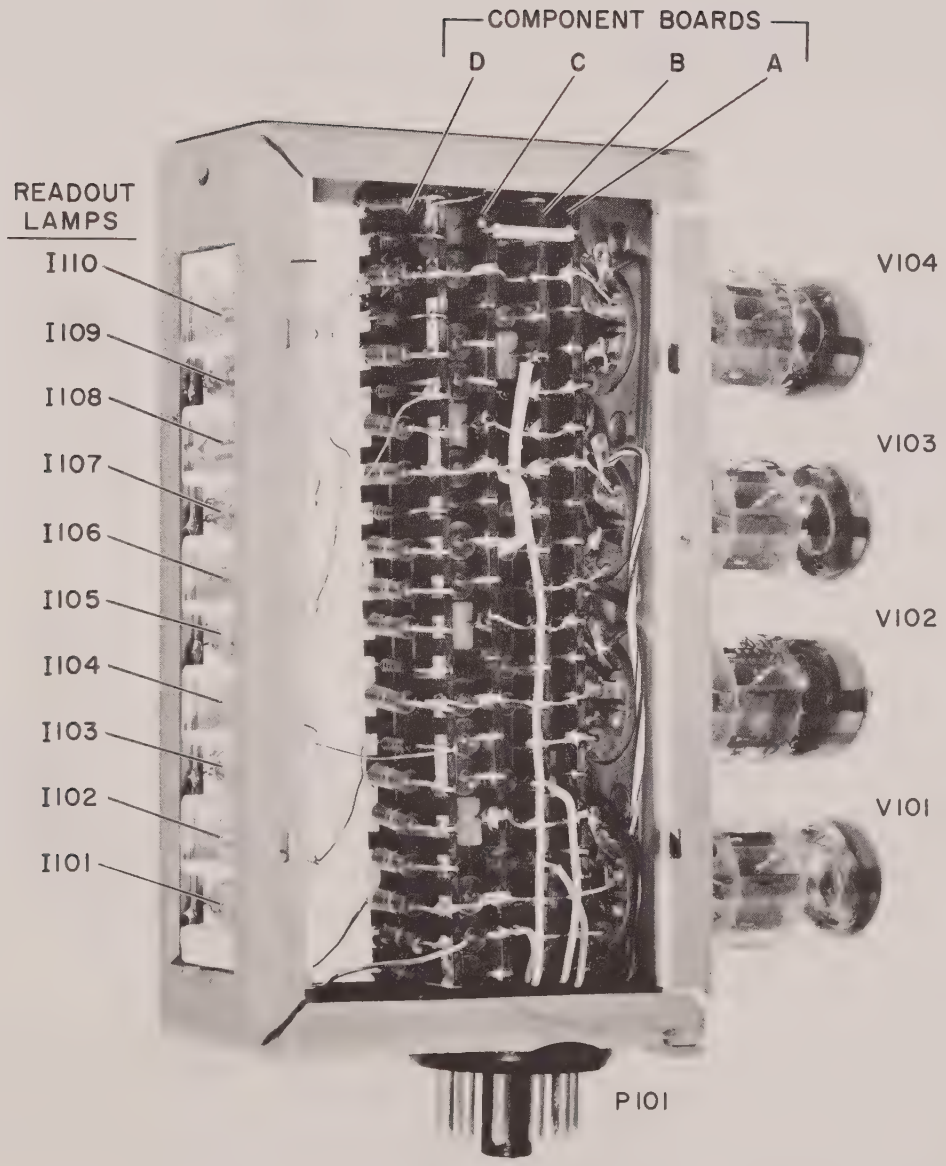


FIGURE 6.

MODEL 785A DCU WITH NUMBER MASK REMOVED

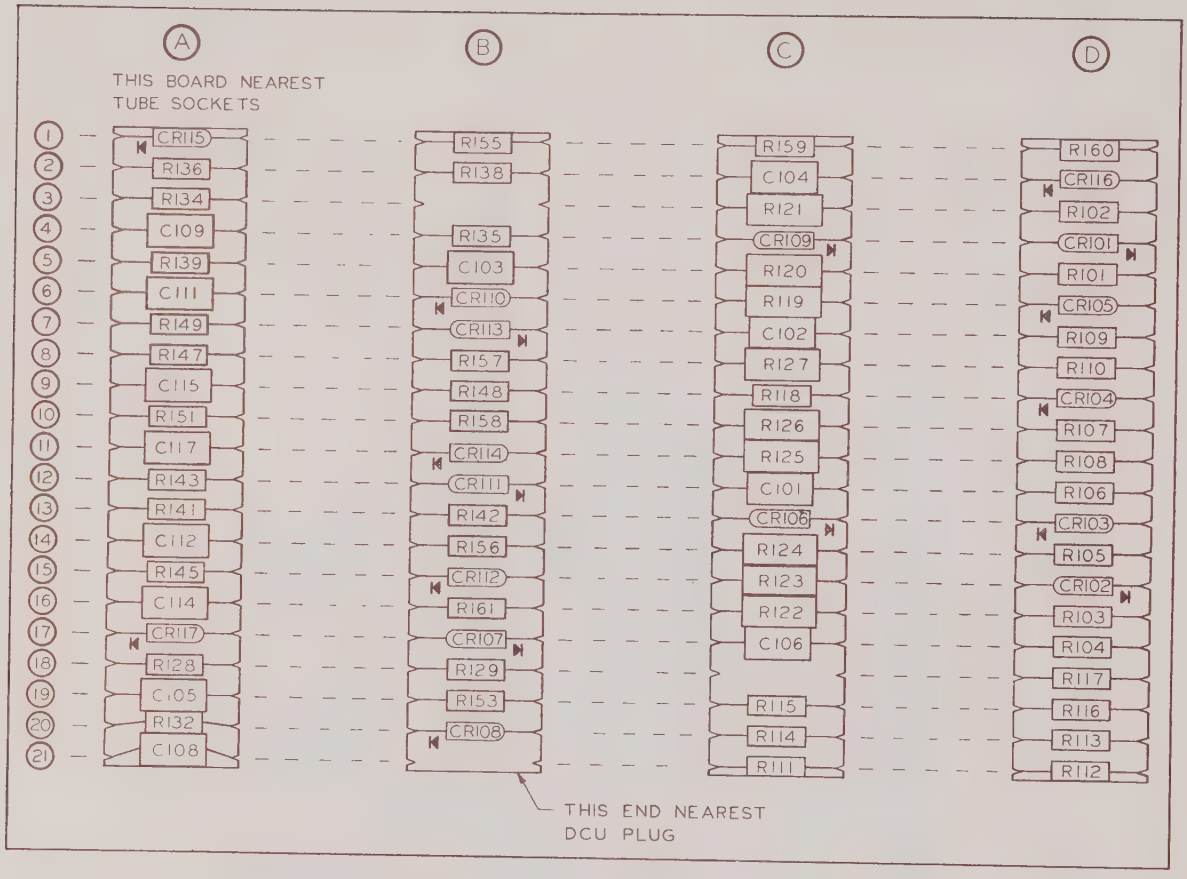


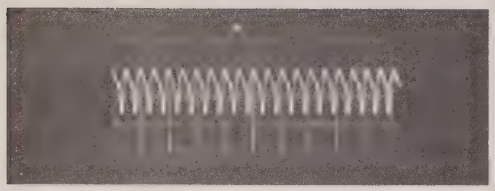
FIGURE 7.

COMPONENT BOARD LAYOUT

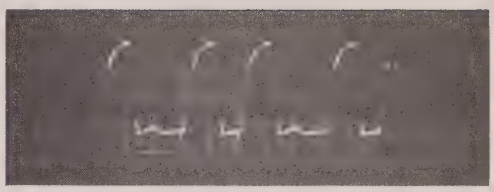
TABLE 4. PARTS LOCATION GUIDE*

Reference Number	Position (Fig. 7)	Reference Number	Position (Fig. 7)	Reference Number	Position (Fig. 7)
C101	C 12	CR115	A 1	R125	C 11
C102	C 7	CR116	D 2	R126	C 10
C103	B 5	CR117	A 17	R127	C 8
C104	C 2			R128	A 18
C105	A 19	R101	D 5	R129	B 18
C106	C 17	R102	D 3	R132	A 20
C108	A 21	R103	D 16	R134	A 3
C109	A 4	R104	D 17	R135	B 4
C111	A 6	R105	D 14	R136	A 2
C112	A 14	R106	D 12	R138	B 2
C114	A 16	R107	D 10	R139	A 5
C115	A 9	R108	D 11	R141	A 13
C117	A 11	R109	D 7	R142	B 13
		R110	D 8	R143	A 12
CR101	D 4	R111	C 21	R145	A 15
CR102	D 15	R112	D 21	R147	A 8
CR103	D 13	R113	D 20	R148	B 9
CR104	D 9	R114	C 20	R149	A 7
CR105	D 6	R115	C 19	R151	A 10
CR106	C 13	R116	D 19	R153	B 19
CR107	B 17	R117	D 18	R155	B 1
CR108	B 20	R118	C 9	R156	B 14
CR109	C 4	R119	C 6	R157	B 8
CR110	B 6	R120	C 5	R158	B 10
CR111	B 12	R121	C 3	R159	C 1
CR112	B 15	R122	C 16	R160	D 1
CR113	B 7	R123	C 15	R161	B 16
CR114	B 11	R124	C 14		

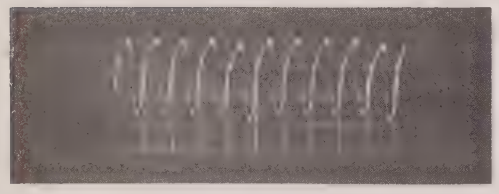
*Parts not listed in this table can be found at the appropriate tube socket terminals.



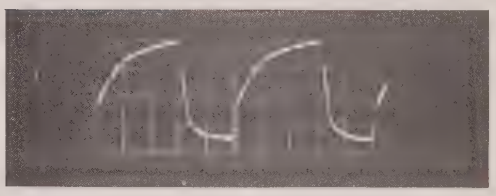
Input Pulses
8 volts peak-to-peak



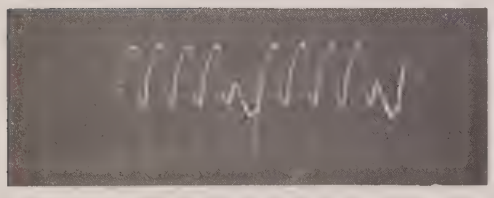
(3) Second Binary Output (V102, Pin 6)
65 volts peak-to-peak



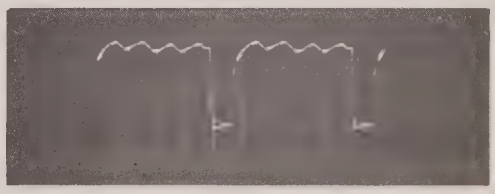
(1) First Binary Output (V101, Pin 6)
65 volts peak-to-peak



(4) Third Binary Output (V103, Pin 6)
65 volts peak-to-peak



(2) Plate of Gate Diode (CR106)
28 volts peak-to-peak



(5) Fourth Binary (V104, Pin 1)
62 volts peak-to-peak

FIGURE 8.
TYPICAL WAVEFORMS WITH INPUT FREQUENCY OF 1 MEGACYCLE. VOLTAGE LEVELS AT HIGH FREQUENCIES MAY DIFFER CONSIDERABLY FROM THOSE SHOWN IN FIGURE 4. (TIME SCALE = 2μSECONDS/CM)

TABLE 5a

VOLTAGES

Note: Voltages measured to ground at count "0" with a vacuum tube voltmeter such as an RCA Volt-ohmyst Senior. B+ voltage is 200 volts.

Tube	Voltages at Tube Pin								
	1	2	3	4	5	6	7	8	9
V101	+170	+42	+56	0	0	+104	+56	+56	6.3AC
V102	+170	+38	+52	0	0	+94	+52	+52	6.3AC
V103	+170	+19	+32	0	0	+78	+33	+32	6.3AC
V104	+170	+37	+50	0	0	+92	+53	+50	6.3AC

TABLE 5b

RESISTANCES

Note: Resistances are measured to chassis ground with the DCU removed from its socket.

Tube	Resistances at Tube Pin								
	1	2	3	4	5	6	7	8	9
V101	23K	33K	7K	∞	∞	25K	26K	7K	∞
V102	26K	18K	5.8K	∞	∞	26K	15K	5.8K	∞
V103	25K	11K	3.4K	∞	∞	24K	11K	3.4K	∞
V104	26K	21K	6K	∞	∞	26K	17K	6K	∞

PARTS LIST

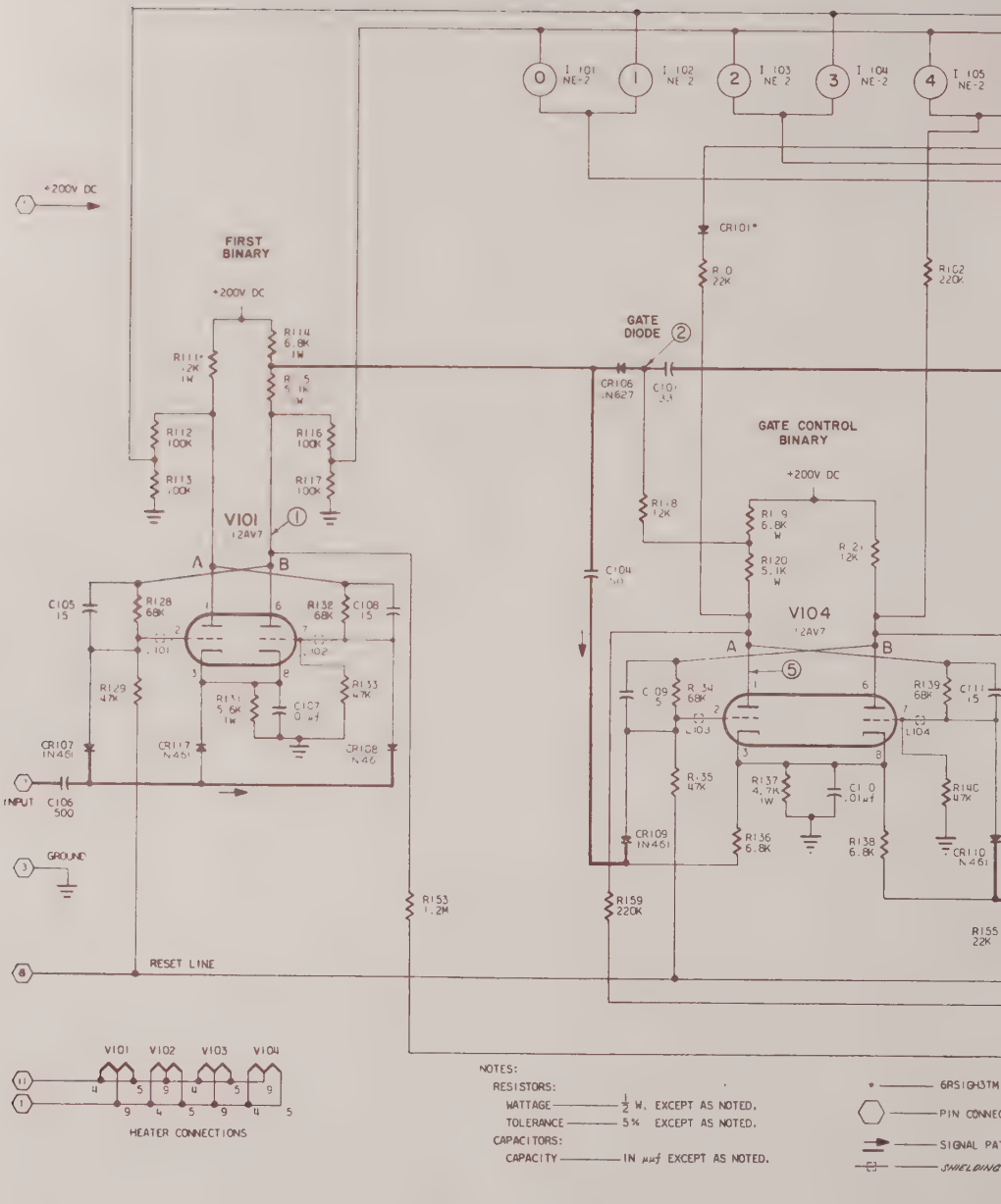
MODEL 785A DECIMAL COUNTING UNIT

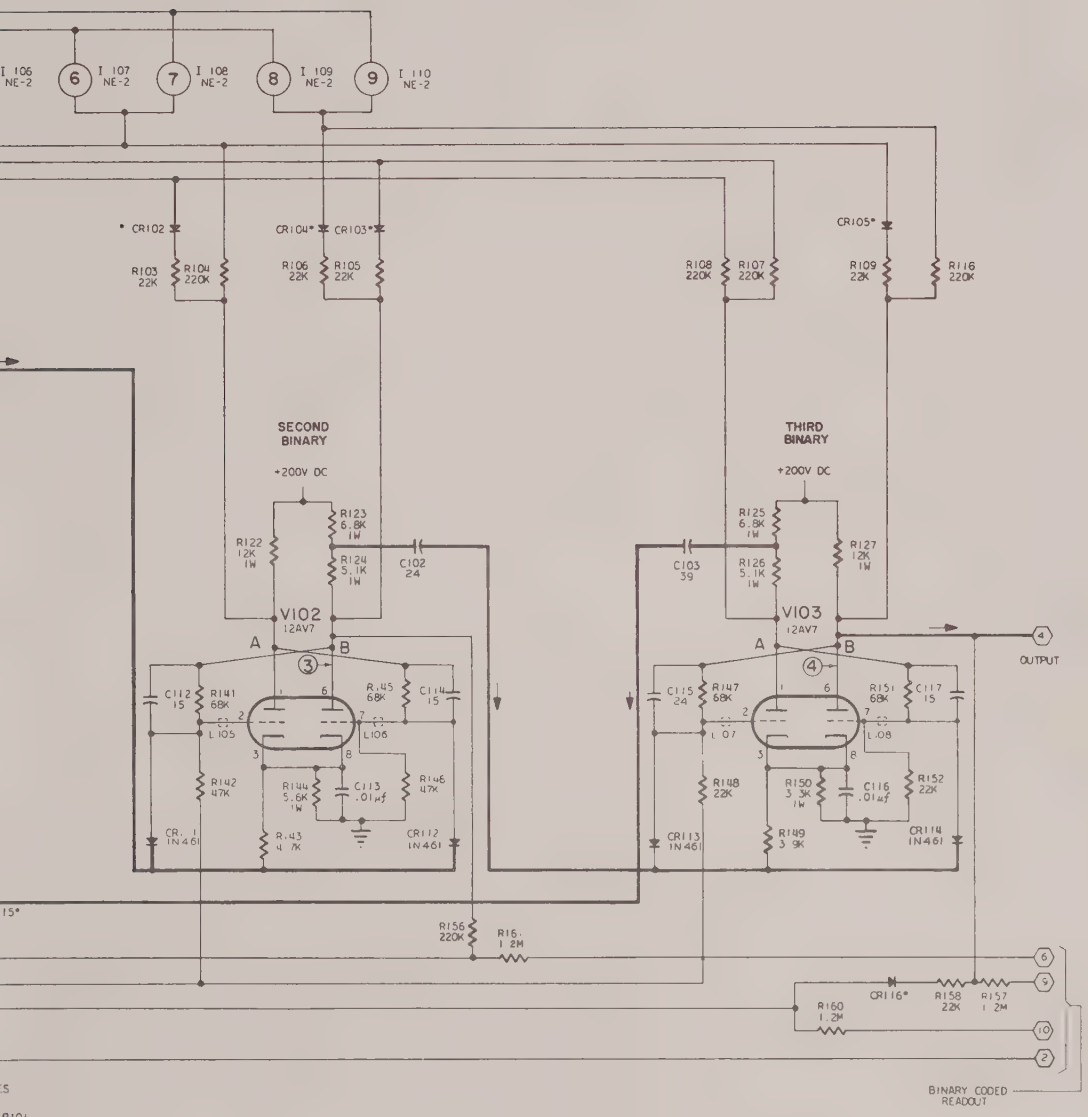
Refer to Dwg. No. 785 D 300

NOTE

The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
C101	2-2607	Capacitor, mica, 33μμf, 500V, 5%	Sangamo RR1433
C102	2-2554	Capacitor, mica, 24μμf, 500V, 5%	Sangamo DR1424
C103	2-3157	Capacitor, mica, 39μμf, 500V, 5%	Sangamo RR1439
C104	2-2141	Capacitor, mica, 50μμf, 500V, 5%	Sangamo RR1450
C105	2-2135	Capacitor, mica, 15μμf, 500V, 5%	Sangamo RR1415
C106	2-2137	Capacitor, mica, 500μμf, 300V, 5%	Sangamo RR1350
C107	2-4388	Capacitor, ceramic, .01μf, 500V, +80 -20%	Sprague 29C9
C108 & C109		Same as C105	
C110		Same as C107	
C111 & C112		Same as C105	
C113		Same as C107	
C114		Same as C105	
C115		Same as C102	
C116		Same as C107	
C117		Same as C105	
CR101	8-4182	Diode, 6RS1GH3TM1	General Electric
CR102 thru CR105		Same as CR101	
CR106	8-7453	Diode, 1N627	
CR107	8-4967	Diode, 1N461	Hughes
CR108 thru CR114		Same as CR107	
CR115 & CR116		Same as CR101	
CR117		Same as CR107	
I101	21-6180	Lamp, NE2A	General Electric
I102 thru I110		Same as I101	
L101	3-7251	Ferrite bead	Ferroxcube 255 T 118 A 205
L102 thru L108		Same as L101	
P101	17-1719	Plug, 11 pin	Amphenol 86CP11
V101	5-5977	Tube, 12AV7	
V102 thru V104		Same as V101	
XV101	4-3317	Socket, 9 pin	Elco 280BC
XV102 thru XV104		Same as XV101	


+200V DC
FIRST BINARY
+200V DC
R114 6.8K 1W
R111* 2K 1W
R115 5.1K W
R112 100K
R116 100K
R113 100K
R117 100K
V101 12AV7
A
B
C105 15
R128 68K
C108 15
R132 68K
C102 .101
C103 .101
R129 47K
R131 5.6K 1W
C107 0.1μf
R133 47K
CR107 IN461
CR117 N461
CR108 N46
INPUT
C106 500
GROUND
RESET LINE
R153 1.2M
I 101 NE-2
I 102 NE-2
I 103 NE-2
I 104 NE-2
I 105 NE-2
CR101*
R101 22K
R102 220K
GATE DIODE
CR106 1N627
C101 .33
GATE CONTROL BINARY
+200V DC
R118 12K
R119 6.8K W
R120 5.1K W
R121 12K
C104 .033
V104 12AV7
C109 5
R134 68K
C104 .103
C105 .104
R139 68K
C111 15
R135 47K
R137 4.7K 1W
C110 .01μf
R140 47K
CR109 1N461
R136 6.8K
R138 6.8K
CR110 N461
R159 220K
R155 22K
V101 V102 V103 V104
HEATER CONNECTIONS
NOTES:
RESISTORS:
WATTAGE — ½ W. EXCEPT AS NOTED.
TOLERANCE — 5% EXCEPT AS NOTED.
CAPACITORS:
CAPACITY — IN μμf EXCEPT AS NOTED.
6RS1GH3TM
PIN CONNEC
SIGNAL PA
SHIELDING



MODEL 785A DCU SCHEMATIC DIAGRAM

September 1960 DWG. NO. 785 D 300

INSTRUCTION MANUAL

MODEL 775P

DECIMAL COUNTING UNIT

Beckman

Berkeley Division
2200 Wright Avenue, Richmond 3, California
a division of Beckman Instruments, Inc

1961

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in posession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

INSTRUCTION MANUAL

MODEL 775P

With the following exceptions, this unit is identical to the Model 775 DCU described in the appended manual.

1. Four diodes, CR101 through CR104, have been added. Each of these is wired from a binary readout line to the coincidence line at pin 3 of the DCU plug, P101.

2. The 1.2 M resistors in the binary code readout lines (R152, R151, R150, R149) have been replaced by 470K resistors.

3. The first binary readout line (pin 2 of the DCU plug) is shunted to ground through a 2.7 M resistor (R153).

4. The -110 volt bus is connected to pin 11 of the DCU plug instead of pin 3.

The additional components are located on component board D, shown here. Boards A, B, and C are unchanged.

The schematic diagram for the Model 775P is shown on the following page. For other information on this DCU, refer to the instruction manual for the Model 775.

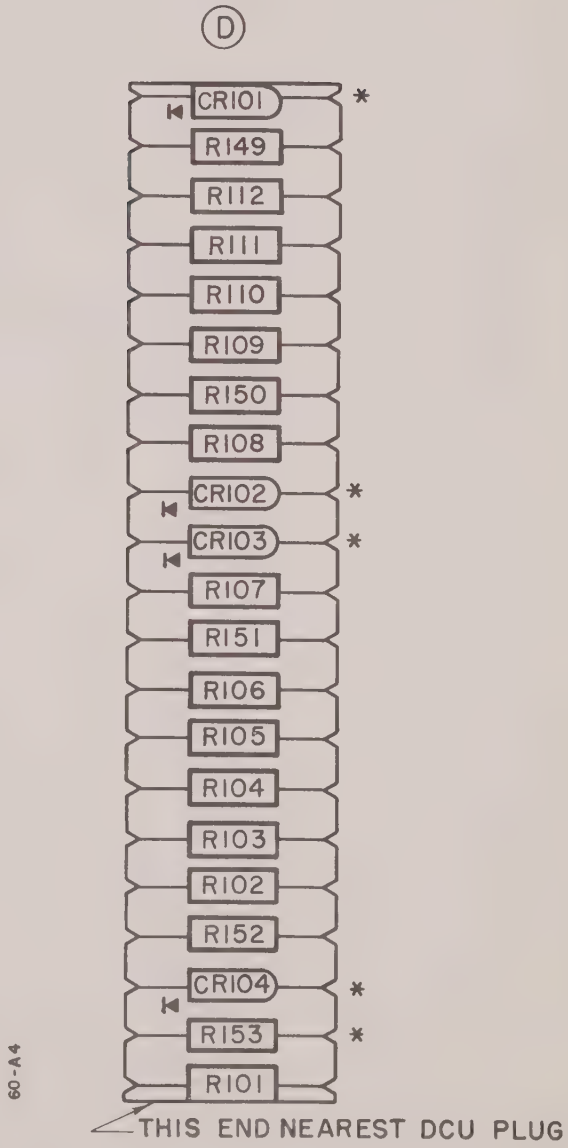


FIGURE 1. LAYOUT OF COMPONENT BOARD D.

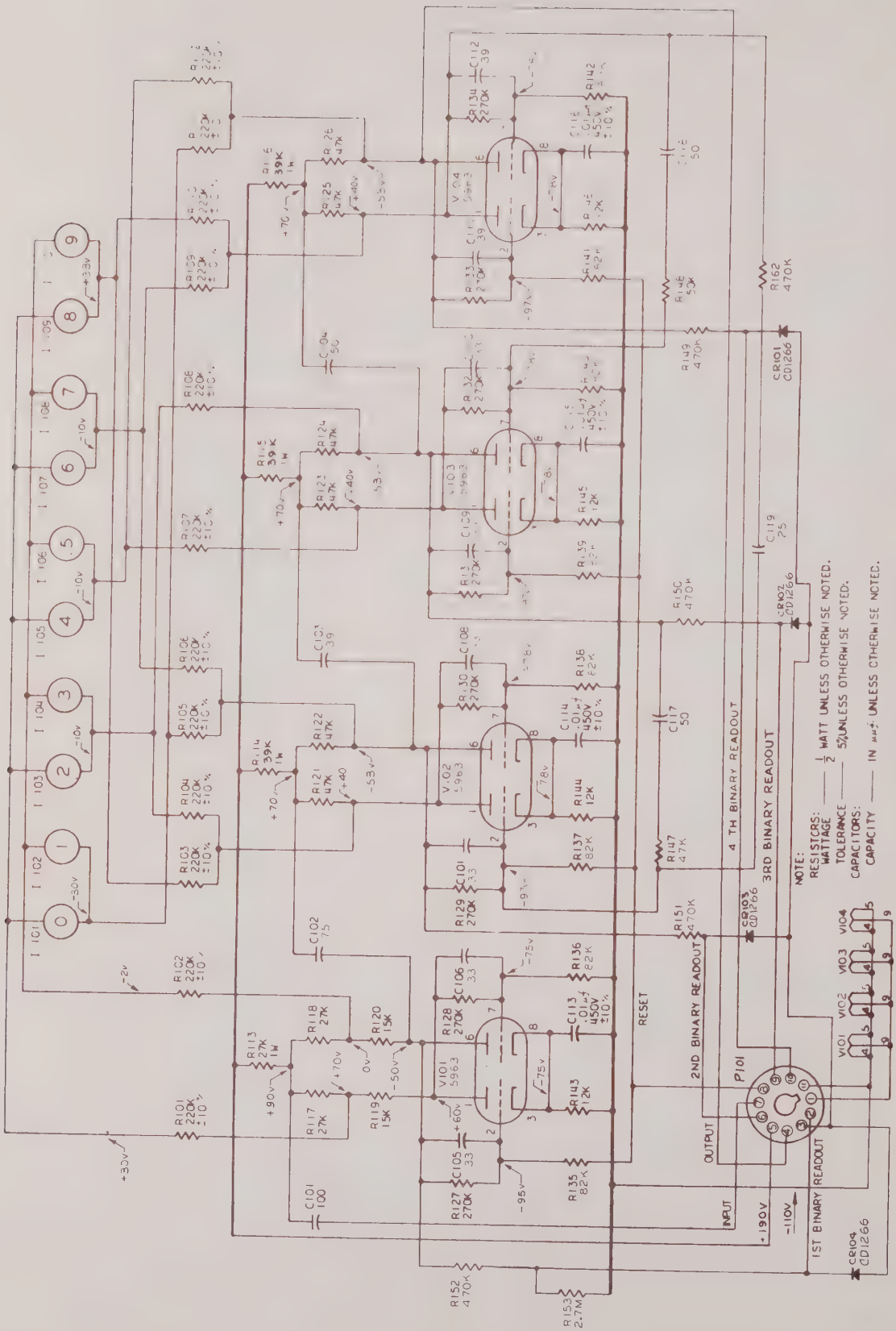


FIGURE 2. MODEL 775P SCHEMATIC DIAGRAM

INSTRUCTION MANUAL

MODEL 775 P/1

DECIMAL COUNTING UNIT

Beckman
Berkeley Division
2200 Wright Avenue, Richmond 3, California
a division of Beckman Instruments, Inc

1961

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in posession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

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Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

INSTRUCTION MANUAL

MODEL 775P/1

With the following exceptions, this unit is identical to the Model 775 DCU described in the appended manual.

1. Four diodes, CR101 through CR104, have been added. Each of these is wired from a binary readout line of the coincidence line at pin 3 of the DCU plug, P101.

2. The 1.2 M resistors in the binary code readout lines (R152, R151, R150, R149) have been replaced by 470K resistors.

3. The first binary readout line (pin 2 of the DCU plug) is shunted to ground through a 2.7 M resistor (R153).

4. The -110 volt bus is connected to pin 11 of the DCU plug instead of pin 3.

5. The ground and reset line connections to R135 and R136 have been reversed so as to make the unit reset to a registered count of one instead of zero.

The additional components are located on component board D, shown here. Boards A, B, and C are unchanged.

The schematic diagram for the Model 775P/1 is shown on the following page. For other information on this DCU, refer to the instruction manual for the Model 775.

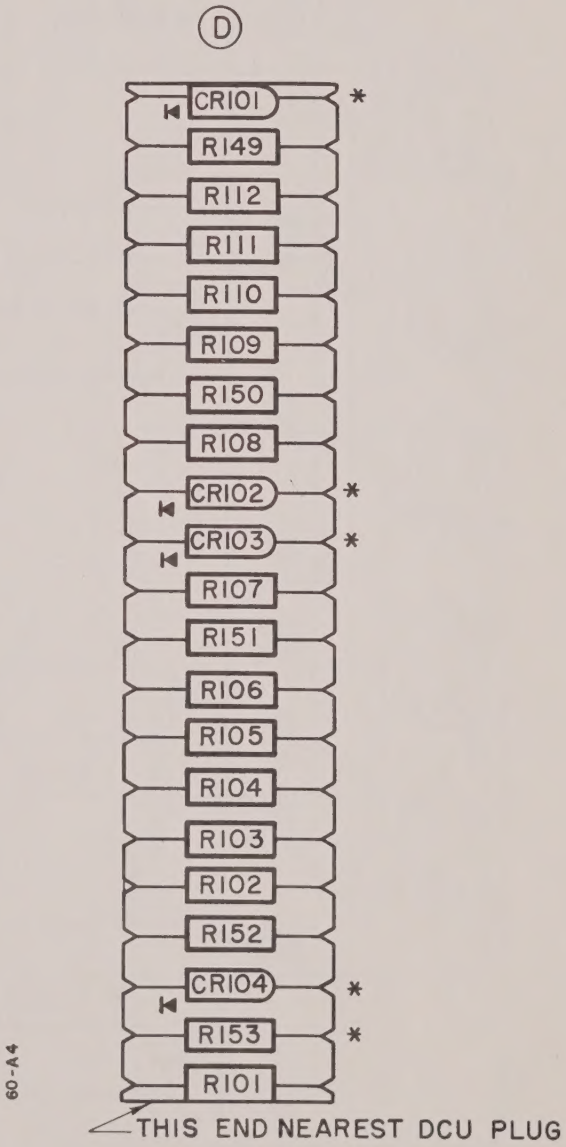

FIGURE 1. LAYOUT OF COMPONENT BOARD D.

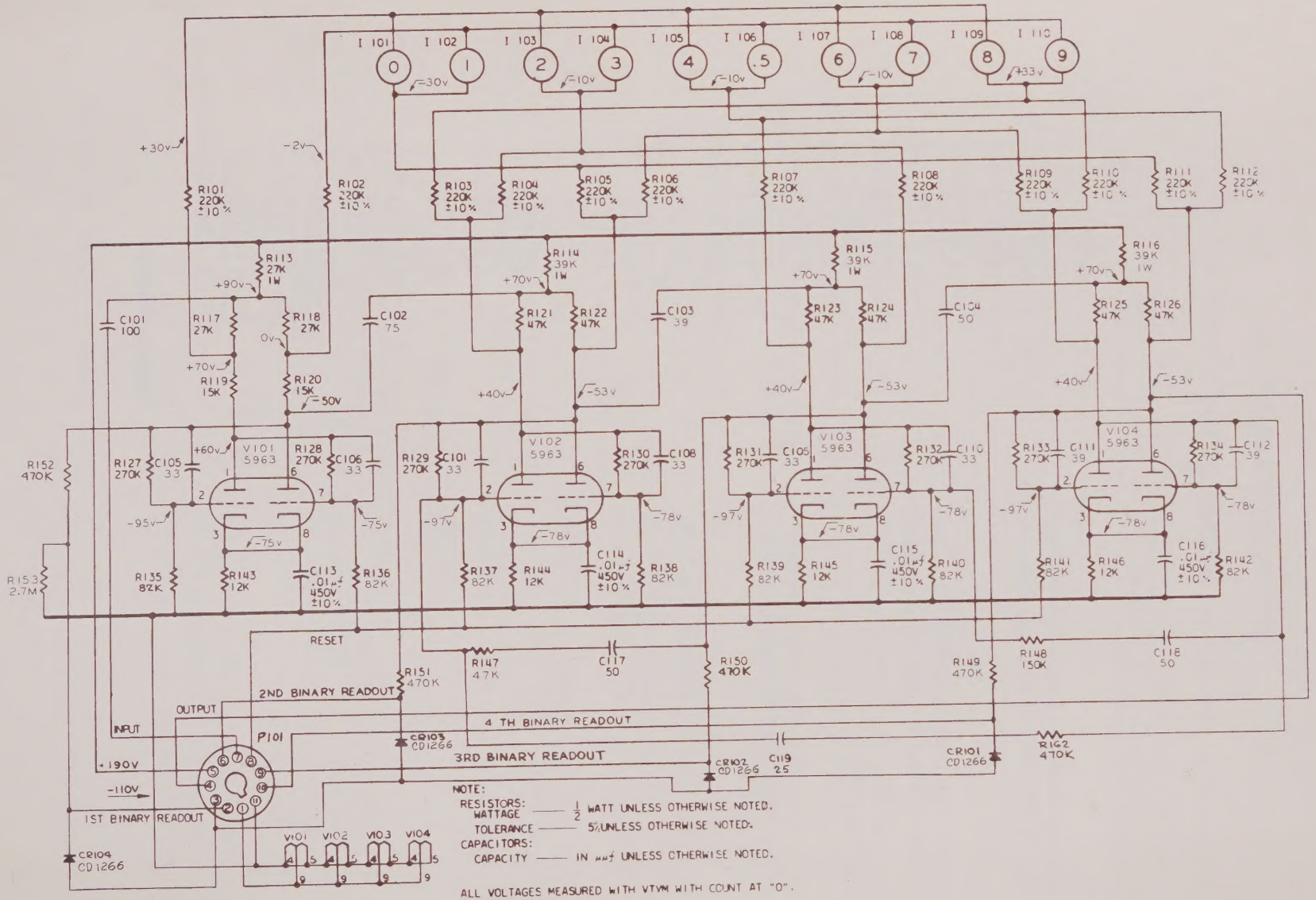

FIGURE 2. MODEL 775P/1 SCHEMATIC DIAGRAM